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Secretaría de Educación
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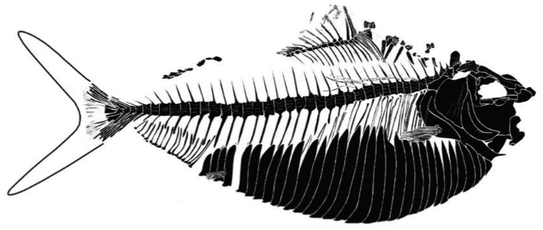
MUSEO DEL DESIERTO
SALTILLO, COAHUILA



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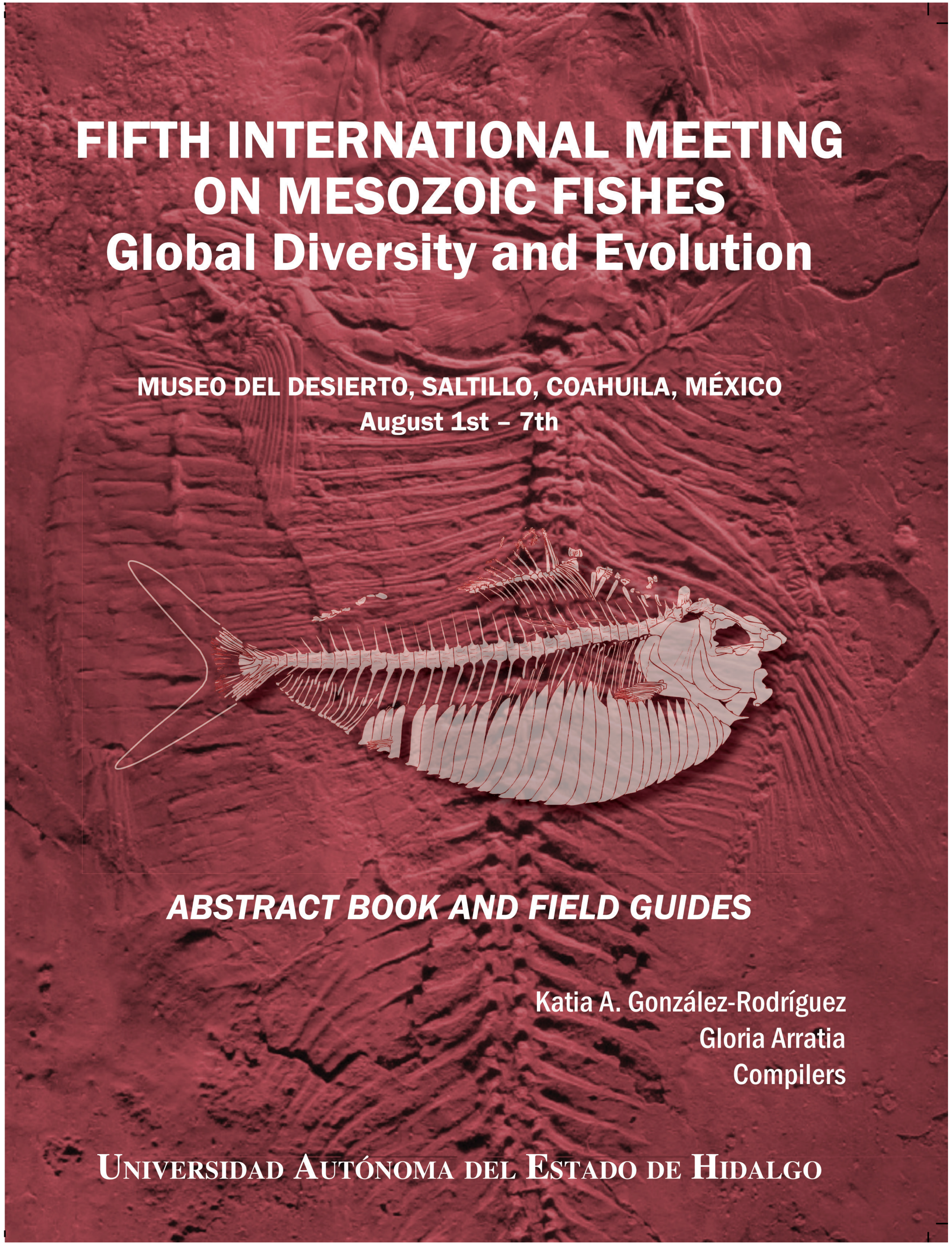
FIFTH INTERNATIONAL MEETING ON MESOZOIC FISHES



FIFTH INTERNATIONAL MEETING ON MESOZOIC FISHES
Global Diversity and Evolution

MUSEO DEL DESIERTO, SALTILLO, COAHUILA, MÉXICO
August 1st – 7th

ABSTRACT BOOK AND FIELD GUIDES

Katia A. González-Rodríguez
Gloria Arratia
Compilers

UNIVERSIDAD AUTÓNOMA DEL ESTADO DE HIDALGO

FIFTH INTERNATIONAL MEETING ON MESOZOIC FISHES
Global Diversity and Evolution

Universidad Autónoma del Estado de Hidalgo

Instituto de Ciencias Básicas e Ingeniería
Área Académica de Biología

19

Ciencia al Día

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Universidad Autónoma del Estado de Hidalgo

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This meeting would not be possible without the work of a number of institutions and people who provided assistance at various levels and during various stages of preparation of the Fifth International Meeting on Mesozoic Fishes: Global Diversity and Evolution. We wish to thank each of them for the help that was rendered. Our first acknowledgment goes to our respective institutions which provided us with the necessary means to make this meeting possible.

Special thanks are extended to G. Arratia (University of Kansas), for her untiring assistance throughout the organization of the meeting.

M. Newbrey (Royal Tyrrell Museum of Palaeontology) is acknowledged and thanked for designing and uploading the webpage of the meeting (http://www.ualberta.ca/~mnewbrey/MFMeeting/index.html), that also includes useful information about Saltillo and the region. Information on this webpage was gathered and provided by C. Ifrim (Institute of Geosciences, Ruprecht-Karls-University), S. Giersh (State Museum of Natural History Karlsruhe), D. Brinkman (Royal Tyrrell Museum of Palaeontology), L. Espinosa-Arrubarrena (Instituto de Geología, Universidad Nacional Autónoma de México), A. Berrueto-Córdova, M. C. Aguillón-Martínez and C. R. Delgado-de Jesús (Coordinación de Paleontología de la Secretaría de Educación y Cultura-Museo del Desierto), and the Secretary of Tourism of Coahuila. H.-P, Schultze (University of Kansas) and M. V. H. Wilson (University of Alberta) offered helpful revisions and comments concerning different aspects of the abstract book and Kathryn Mickle (University of Kansas) improved the style of some of the abstracts.

Deep appreciation is expressed to Arturo H. González-González, Director of the Museo de Desierto for providing the installations and for his contribution to the welcome dinner; to the staff of the Museo del Desierto for giving assistance to the participants, conducting the museum tour, helping with the power point presentations and organizing the coffe breaks; to C. D. Luis Gil-Borja, former President of the University of Hidalgo and M.C. Octavio Castillo-Acosta, Director of the Instituto de Ciencias Básicas e Ingeniería, for providing financial support for the abstract book through the PIFI Program; to the personnel of the Publishing house Ediciones y Publicaciones of the University of Hidalgo for their technical assistance with the preparation of the abstract book; to the Instituto de Geología de la Universidad Nacional Autónoma de México for facilities with the field trip to Tlayúa Quarry; and M. C. Perrilliat for showing the fish collection.

We express our gratitude to the Aranguthy Family, Tepexi de Rodríguez, Puebla, for their hospitality during the field visit to the Tlayúa Quarry.

We deeply appreciate the hospitality and collaboration of Lic. José Guadalupe Sánchez-Rangel, Major of General Cepeda, for offering the farewell dinner to the participants.

Organizing committee

THE FIFTH INTERNATIONAL MEETING ON MESOZOIC FISHES —DEDICATED IN THE HONOR OF SHELTON P. APPLEGATE

The Fifth International Meeting on Mesozoic Fishes, which is taking place in the City of Saltillo, Coahuila, México, is dedicated to the memory of Dr. Shelton (Shelly) Pleasants Applegate (1928-2005).

Shelly Applegate, a paleontologist for almost 50 years, spent his career working on a variety of different topics. As an undergraduate and graduate student, he investigated many groups of fossil plants and animals in his home state of Virginia, U.S.A. As a Ph.D. candidate at the University of Chicago, he developed a keen interest in Mesozoic Fishes while investigating the Cretaceous ichthyofauna of the Selma Formation from Alabama, U.S.A.

For over 20 years, he collaborated with many universities and museums in the United States (Duke, Chicago, Arkansas State, the Smithsonian Institution and the Los Angeles County Museum of Natural History, among others) where he studied marine mammals and bony fishes and developed several methods that were pivotal in the field of fossil shark teeth research.

From 1976 to the unfortunate time of his death in 2005, Shelly worked for the Geological Institute at UNAM (National Autonomous University of México). In his “new” home, he started the study of fossil sharks (the Cipactli Group), triggered many investigations on Mexican dinosaurs, promoted many paleontological expeditions in Baja California, and most importantly, started a research group dedicated to the study of Mesozoic fishes. His work in this field started with a project in southern México (State of Puebla) in a Cretaceous quarry called Tlayúa, the Nahuatl word for dawn.

The discovery of the Tlayúa quarry in 1981 marked a new era in the study of fossil fishes in México. With time, this site has become the most important fossil locality in the country and in some respects it is unique to North America.

The extraordinary kindness and love for México and its culture that Shelly demonstrated had a huge impact on paleontology in México—as evidenced by the collection of more than 6500 fossils from Tlayúa and the creation of the “Museo Regional Mixteco: Tlayúa” (the site museum that will be visited in one of the meeting’s field trips). The specimens from Tlayúa have greatly increased the collections at the National Paleontological Collection, UNAM, and include over 5000 Mesozoic fishes.

For many of us Shelly was more than a fellow researcher and a friend; he was an enthusiastic and passionate teacher. Without a doubt, he is considered the founder of “Mexican Paleoichthyology”. His keen interest in Mesozoic fishes (his presence at the Mesozoic Fishes meetings was emblematic), his sincere love for the Mexican countryside, and his appreciation for Earth Sciences, fiestas (parties), Tequila and Mezcal are still living in the new generations of Mexican paleoichthyologists. We want to thank and honor Shelly Applegate for all his instruction and friendship, and want to dedicate this Mesozoic Fishes Meeting to him.

Luis Espinosa Arrubarrena & Katia A. González Rodríguez

Program

Sunday, August 1st

16:00 – 18:30	REGISTRATION
19:00	WELCOME DINNER IN MUSEO DEL DESIERTO

Monday, August 2nd

8:30 – 9:30	Registration
Moderator	*R. Gómez*
9:30 – 9:45	Welcome by the Director of Museo del Desierto, A. González-González.
9:45 – 10:30	Dr. Shelton Applegate. A dedication by L. Espinosa-Arrubarrena.
10:30 – 10:45	General Information.
10:45 – 11:00	*Coffee break*
11:00 – 12:00	J. Alvarado-Ortega, K. A. González-Rodríguez, L. Espinosa Arrubarrena, G. González-Barba, B. A. Than-Marchese & H. Porras-Múzquiz — Mexican Mesozoic fishes: The state of the art at the beginning of the XXI century.
12:00 – 12:30	K. González-Rodríguez & V. H. Reynoso. — A new macrosemiid (Halecostomi) from the Albian Tlayúa Quarry, central México.
12:30 – 13:00	M. P. Melgarejo-Damián & J. Alvarado-Ortega. — A multivariate approach on the Ellimmichthyiformes of Tlayúa Quarry (Lower Cretaceous), Tepexi de Rodríguez, Puebla, México.
13:00 – 14:30	*Lunch*
14:30 – 15:30	Visiting the sections of Fauna and Flora of the region in the Museo del Desierto.
Moderator:	*J. Alvarado-Ortega*
15:30 – 16:00	C. Ifrim, W. Stinnesbeck, E. Frey, S. Giersch, J. G. López-Oliva & A. H. González-González. — Research into the Turonian (Late Cretaceous) fossils from the platy limestone at Vallecillo, Nuevo León, México – State of the art.
16:00 – 16:15	*Coffee break*
16:15 – 16:45	S. Giersch, E. Frey, C. Ifrim, W. Stinnesbeck & A. H. González- González.

	— The ichthyofauna from the Upper Cretaceous locality Vallecillo (Northeastern México).
16:45 – 17:15	H. Martín-Abad & F. J. Poyato-Ariza. — An actuotaphonomical approach to factors of fish preservation in Konservat-Lagerstätten.
17:15	Opening of a special exhibition on Selected Mexican Fossil Fishes.
20:00	*Dinner*

TUESDAY, AUGUST 3RD

Moderator:	*H.-P. Schultze*
9:00-9:45	A. Tintori. — Not only Monte San Giorgio: a new deal for Middle Triassic Fishes.
9:45-10:15	R. J. Mutter. — Actinopterygians from the Lower Triassic Upper Beaufort Group (South Africa) document marine influence in the Karoo Basin during Early Triassic.
10:15 – 10:45	D. D. Bermúdez-Rochas & F. J. Poyato-Ariza. — A new semionotiform from the Upper Jurassic of Spain.
10:45 – 11:00	*Coffee Break*
11:00 – 11:30	U. Deesri. K. Lauprasert, V. Suteethorn, S. Thongnak, K. Wongko & L. Cavin. — A new semionotiform fish (Actinopterygii, Neopterygii) from the Phu Kradung Formation (Upper Jurassic-Lower Cretaceous) of northeastern Thailand.
11:30 – 12:00	L. Cavin, E. Buffetaut, U. Deesri & V. Suteethorn. — Possible ecological association between semionotiform fishes and spinous dinosaurs.
12:00 – 12:30	A. Tintori & Z.-y. Sun. — A new Anisian (Middle Triassic) fish-level near Dawazi (Luoping County, Yunnan Province, P.R. China): dating the post Permo/Triassic crisis reappraisal.
12:30 – 13:00	R. W. Berrell, A. Kemp, J. Alvarado-Ortega, Y. Yabumoto & S. W. Salisbury. — Mesozoic fishes from Australia.
13:00 – 14:30	*Lunch*
Moderator:	*M. Newbrey*
14:30 – 15:30	F. J. Poyato-Ariza. — Pycnodonts and actinopterygian faunal replacement in Europe during the Cretaceous.
15:30 – 16:00	J. Liston & M. Friedman. — An era of suspense: The ecological evidence and Mesozoic record of a lineage of large osteichthyan suspension feeders.
16:00 – 16:15	*Coffee break*

16:15 – 16:45 H. Martín-Abad & F. J. Poyato-Ariza. — Amiidae from the Lower Cretaceous of Spain and their bearing on some taxonomic issues.
16:45 – 17:15 N. Micklich & M. G. Newbrey. — Growth cessation marks in bowfins -- a tool for biological and paleoecological reconstructions.

17:15 – 19:00 Poster Session 1

20:00 Dinner

WEDNESDAY, AUGUST 4TH

Moderator K. A. González-Rodríguez

9:00 – 9:30 A. Tintori, Z.-y. Sun, T. Hitij, C. Lombardo, D.-y. Jiang & J. Alohar. — Short and long distance diversities in the fish assemblages of the Middle Triassic.
9:30 – 10:00 H.-P. Schultze & G. Arratia. — The basins of the Lithographic Limestone of southern Germany and the rise of new fish groups.
10:00 – 10:45 P. M. Brito. — The importance of the fossil fishes from the Lower Cretaceous of Brazil.

10:45 – 11:00 Coffee break

11:00 – 11:30 L. Cavin, F. Ciaramelli & R. Martini. — The Late Hauterivian (Early Cretaceous) fish assemblage from the mountain of Voirons, Haute-Savoie, France.
11:30 – 12:00 J.-y. Zhang. — A fish fauna from the Upper Cretaceous of Songliao Basin, northeast China.
12:00 – 12:30 D. B. Brinkman, M. Newbrey, A. G Neuman & J. G. Eaton. — Non-marine actinopterygian fish assemblages from the Upper Cretaceous of the Western Interior of North America - Evidence from vertebrate microfossil localities.
12:30 – 13:00 A. F. Bannikov, G. Carnevale & R. Zorzin. — A new Cenomanian marine fish assemblage from southeastern Morocco.

13:00 – 14:30 Lunch

Moderator M. V. H. Wilson

14:30 – 15:15 G. Arratia. — New Jurassic teleosts from the Upper Jurassic of Bavaria, southern Germany.
15:15 – 15:45 K. J. Irwin & C. Fielitz. — Ichthyodectiform fishes from the Upper Cretaceous (Campanian) of Arkansas, U.S.A.
15:45 – 16:15 P. M. Brito, D. Dutheil & F J. Meunier. — A new notopterid (Teleostei, Os-

teoglossomorpha) from the Upper Cretaceous Kem Kem Beds, Morocco.

16:15 – 16:30 *Coffee break*

16:30 – 17:00 N. Bonde & J. Alvarado-Ortega. — Eocene, marine osteoglossomorphs and implications for the distribution of this group in the Cretaceous.
17:00 – 17:30 A. M. Murray & M. V. H. Wilson. — New paraclupeid fishes (Teleostei: Clupeomorpha: Ellimmichthyiformes) from the Upper Cretaceous of Morocco.
17:30 – 18:00 M. Davis, G. Arratia & T. Kaiser. — Fossils of the family Kneriidae (Teleostei: Gonorynchiformes) from the Eocene lake of Mahenge (Tanzania).
18:00 – 18:30 D. Mayrinck, O. Otero & P. M. Brito. — Anatomical review of †*Salminops ibericus* Gayet, 1985 (Ostariophysi, Salminopsidae) from the Cenomanian of Caranguejeira Formation, Leiria, Portugal.

20:00 *Dinner*

THURSDAY, AUGUST 5th

Moderator *G. Cuny*

9:00 – 9:30 T. Grande, L. Smith & W. C. Borden. — Phylogenetic relationships of basal eucanthomorph fishes: a preliminary assessment of morphological and molecular data.
9:30 – 10:00 B. Kalloufi. — To be or not to be a Mesozoic stomiiform. Three candidates from Jbel Tselfat (Cenomanian-Turonian, Morocco).
10:00 – 10:30 M. G. Newbrey, M. V. H. Wilson, A. G. Neuman, A. M. Murray & D. B. Brinkman. — A new genus of Percopsiformes from the Upper Cretaceous Scollard Formation of Alberta, Canada.
10:30 – 11:00 K. González-Rodríguez & H.-P. Schultze. — A fossil agonid (Actinopterygii, Teleostei, Percomorphacea) from the Albian-Cenomanian of México.

11:00 – 11:15 *Coffee break*

11:15 – 12:45 J. Adolfssen. — The end of the Mesozoic sharks from the white chalk and the KT-boundary at Stevns Klint, Denmark.
11:45 – 12:15 D. D. Bermúdez. — The Mesozoic record of chondrichthyans from the Iberian Peninsula, with special attention to the Hybodontiformes.
12:15 – 12:45 T. D. Cook, M. G. Newbrey, A. M. Murray, M. V. H. Wilson, K. Shimada, G. T. Takeuchi & J. D. Stewart. — Partial skeletal remains of *Archaeolamna kopingensis* (Lamniformes) from the Upper Cretaceous Pierre Shale of western Kansas.
12:45 – 13:15 G. Cuny, O. Cheeychiw, C. Laojumpon & K. Lauprasert. — New species of

Heteroptychodus (Elasmobranchii: Hyobodontiformes) from the Lower Cretaceous of Thailand.

13:15 – 14:30 Lunch

Moderator J.-y. Zhang

14:30 – 14:45 S. Giersch, E. Frey, W. Stinnesbeck, C. Ifrim, & A. H. González- González. — Ptychodontid sharks from the Upper Cretaceous locality Vallecillo (north-eastern México).

14:45 – 15:15 A. Kemp & R. W. Berrell. — Lungfish as environmental indicators.

Special Session on certain localities (no abstracts)

15:15 – 15:30 D. D. Bermúdez-Rochas. — La Vega de Pas 1 locality (Basque-Cantabrian Basin): a Lower Cretaceous freshwater fluviolacustrine locality on an actual freshwater river.

15:30 – 15:45 G. Cuny. — Phu Phan Thong: On the difficulty to exploit a tropical road bank.

15:45 – 16:00 D. D. Bermúdez-Rochas. — La Rioja province (Camoros Basin, Spain): even more fishes than dinosaurs.

16:00 – 16:15 Coffee Break

16:15 – 16:45 L. Cavin. — The "Hill of the Spring" locality (Phu Nam Jun) from the Upper Jurassic – Lower Cretaceous of Isan, NE of Thailand.

16:45 – 17:00 C. Fielitz. — Campanian marine fauna of Arkansas (USA).

17:00 – 17:30 M. Newbrey, A, Neuman & D. Brinkman. — The Pisces Point locality (Scollard Fm., Maastrichtian), a new look at an old locality in Alberta, Canada

17:30 – 18:00 C. Ifrim & S. Giersch. — Vallecillo.

18:00 – 18:30 G. Gonzalez-Barba. — Fossiliferous richness of Baja California: Cenozoic Marine Record.

20:00 Dinner

FRIDAY, AUGUST 6th

Moderator T. Grande

9:00 – 9:30 T. Grande. — Advances and problems of standardizing morphological data.

9:30 – 10:00 K. Mickle. — Revisiting the morphology of the actinopterygian preoperculum.

10:00 – 10:30 J. Liston. — Gill raker characteristics and their validity as a taxonomic tool: problems within Pachycormiformes.

10:30 – 11:00 G. Arratia & H.-P. Schultze. — About some remarkable morphological characters in certain pachycormiforms.

11:00 – 11:15 *Coffee break.*

11:15 – 12:00 H.-P. Schultze & G. Arratia. — The caudal skeleton of teleosts: revisited.
12:00 – 12:30 F. Pfeil. — A publisher's view of shark teeth and their study.
12:30 – 12:45 S. Giersch, J. M. Padilla Gutiérrez, E. Frey, W. Stinnesbeck, C. Ifrim & A. H. González-González. — Preparation of fossil fishes from Vallecillo- improved method allows for detailed anatomical studies.
12:45 – 13:00 L. Machado. — Acid preparation techniques.

13:00 – 14:30 Lunch

Moderator T. Grande

14:30 – 15:00 G. Arratia & H. Tischlinger. — What can the light do?
15:00 – 15:45 M, V. H. Wilson. — The art of preparing manuscripts for submission to Mesozoic Fishes, JVP, and other journals.

15:45 – 17:45 Poster Session 2

Moderator: G. Arratia

17:45 "Business" meeting

Closing the 5th International Meeting ON Mesozoic Fishes

20:00 Dinner

POSTERS SESSION 1: AUGUST 3RD

1: J. Alvarado-Ortega & P. M. Brito. — On the occurrence of *Araripichthys* in the Tlayúa Quarry (Albian), Central México.
2: C. Amaral, J. Alvarado-Ortega & P. M. Brito. — A new gonorynchiform fish from the Cenomanian of the Sierra Madre Formation, Chiapas, México.
3: N. Bonde. — Lampridiformes of the Cretaceous and Paleogene - A preliminary presentation.
4: A. L. Cione & M. M. Azpelicueta. —Catfish diversity in the Cretaceous of South America.
5: C. Cupello & P. M. Brito. — An overview of the ?Late Jurassic fish fauna from the Missão Velha Formation (Araripe Basin,

northeastern Brazil).

6: P. G. Giordano. — “Pholidophoriforms” of La Cantera Formation, Lower Cretaceous, San Luis, Argentina.

7: G. González-Barba, S. Aguirre-Garza, R. Guajardo-Guajardo & H. Porras-Múzquiz. — Maastrichtian sharks of the Escondido Formation in the Sabinas Basin, northern Coahuila.

8: G. González-Barba & H. Rivera-Sylva. — Late Cretaceous sharks from the Pen Formation in northwestern Coahuila, México.

9: C. Hernández-Guerrero & K. A. González-Rodríguez. — The pachyrhizodontid fishes of the Muhi Quarry (Albian-Cenomanian), Hidalgo, México.

10: C. Ifrim, E. Frey, W. Stinnesbeck & S. Giersch. — Scientific excavation *versus* random collection in a fossil Lagerstátte – A case study at Vallecillo, NE México.

11: J. Liston. — The first ichthyodectiform? from Scotland.

12: L. P. Machado & J. Alvarado-Ortega. — A new pycnodontid species from the Lower Cretaceous of the Tlayúa Quarry, central México.

POSTERS SESSION 2: AUGUST 6TH

1: N. Bonde. — Elopiforms: new, large elopoids from the Cretaceous and Early Tertiary.

2: L. Cione & S. Gouric Cavalli. — A species of the Australian lungfish genus *Metaceratodus* in Upper Cretaceous beds of South America.

3: G. González-Barba & H. Porras-Múzquiz. — Partial skeleton of *Squalicorax falcatus* (Lamniformes: Anacoracidae) from the Eagle Ford Formation (Turonian) in Los Temporales Quarry, northwest of Múzquiz, Coahuila.

4: C. Ifrim, E. Frey, W. Stinnesbeck & S. Giersch. — Databases as key to understanding fossil Lagerstätten – an example for Vallecillo, northeastern México.

5: G. Machado, J. Alvarado-Ortega & P. M. Brito. — A new ophiopsid from Tlayúa Quarry (Lower Cretaceous, Albian), Puebla, Central México.

6: L. P. Machado, M. F. C. Pereira & P. M. Brito. — A redescription of *Pycnodus laveirensis* (Pycnodontiformes, Pycnodontidae) from the Cenomanian of Laveiras, Portugal.

7: R. J. Mutter. — *Serrolepis*, a little known polzbergiid actinopterygian from the lower Keuper (Middle Triassic) of Baden-Württemberg (Germany).

8: D. Pérez-Sánchez & K. A. González-Rodríguez. — Clupeomorphs from El Doctor Formation (Cretaceous: Albian-Cenomanian), Zimapán, Hidalgo State, México.

9: F. Riquelme, J. Alvarado-Ortega, J. L. Ruvalcaba-Sil, M. Aguilar-Franco & A. Moreno. — Internal soft anatomy and organic fluid-like pattern preserved in fishes (Clupeomorpha) from Tlayúa Quarry Lower Cretaceous Lagerstätte, México.

10: S. Spears. — Late Triassic semionotiform fishes from southern Utah, United States.

11: B. A. Than-Marchese & J. Alvarado-Ortega. — The first record of Aipichthyoidea (Teleostei, Acanthomorpha) in México.

12: Y. Yabumoto & P. M. Brito. — Second record of a coelacanth from the Lower Cretaceous Crato Formation, Araripe Basin, northeastern Brazil, with comments on the development of coelacanths.

THE END OF THE MESOZOIC, SHARKS FROM THE WHITE CHALK AND THE KT-BOUNDARY AT STEVNS KLINT, DENMARK

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The locality Stevns Klint, in Denmark offers a unique opportunity to study changes in shark diversity across the KT-boundary in the boreal sea, as the stratigraphic succession at the location is unbroken.

The uppermost Maastrichtian at Stevns Klint is characterized by a grey bryozoan–foraminiferal wackestone with a coccolith chalk matrix. The chalk is overlaid by the Fish Clay as a result of an abrupt change from carbonate into clay sedimentation at the boundary to the Danian. This boundary clay itself is overlaid by limestone as the carbonate sedimentation recovered.

The Maastrichtian fauna is characterized by large Lamniformes (Squalicorax and Cretalamna) and small Squaliformes (Etmopterus), whereas the lowermost Danian fauna is strongly dominated by small Lamniformes (Carcharias) and Carcharhiniformes (Palaeogaleus), which appear to be disaster species as they vividly outnumber al other species.

The distinct layers in the successions and the abundances of fossil shark teeth make it possible to reconstruct the fauna and observe changes in the diversity across the boundary.

ON THE OCURRENCE OF ARARIPICHTHYS IN THE TLAYÚA QUARRY (ALBIAN), CENTRAL MÉXICO

Jesús ALVARADO-ORTEGA[1] & Paulo M. BRITO[2]

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Araripichthys is a rare fish found in localities spread in the western realm of the Tethys Sea, including three nominal species: A. castilhoi from the Aptian or Albian deposits of the Santana Formation, Brazil; A. corythophorus from lower Turonian deposits at Goulmima, Morocco; and A. axelrodi from Aptian strata of Rosarito quarry, Apton Formation, Venezuela. An isolated and poorly preserved specimen from the Turonian strata of Vallecillos quarry, México still requires a formal description.

Recently, remains of an Araripichthys specimen was collected in the Albian lithographic limestone strata of Tlayúa quarry, México. Although incomplete, the head, jaws, and part of the abdominal region are preserved in this fish. This specimen shares with the nominal Araripichthys species the presence of an elongate ascending process in the premaxilla and an expanded supramaxilla. This finding increases the geographic range of Araripichthys within the Early Cretaceous, outlining its western Tethys Sea biogeographical area, from Brazil to México, a range that was also shared by other Early Cretaceous fishes such as the aspidorhynchiform Vinctifer.

MEXICAN MESOZOIC FISHES: THE STATE OF THE ART AT THE BEGINNING OF THE XXI CENTURY

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Mexican Mesozoic fossil fish localities are numerous, even though many have not been studied in detail because of the scarcity of specialists. To correct this deficiency, a group of Mexican paleoichthyologists has started the study of various sites (at least 15) in recent years. Five localities are known since the late XIX Century (i.e. Tlayúa, Vallecillos, Muhi) and the other ten represent recent discoveries (i.e. La Mula, San José de Gracia, El Chango). The preliminary results of this survey show that the distribution of these “Tethyan” faunas encompasses vast areas in northern, central and southern México and that their diversity is amazing. So far, no Triassic localities have been found; nevertheless, two potential areas are presently under prospection. Regarding the Jurassic, only two sites have been reported in central México.

Most of the Mesozoic Mexican fossil fish localities (over 13) are Cretaceous in age, including both, Early and Late Cretaceous. Around 20 fossil fish taxa, described in recent years, mostly from the Cretaceous, represent new taxa belonging to the Macrosemiidae, Ionoscopidae, Pycnodontiformes, Pachyrhizodontidae, Ichthyodectyformes, Ichthyotringidae, and Acanthomorpha, among others. These new records represent important implications in the phylogenetic patterns of the groups and will expand the geochronological and distributional range of the taxa. Additionally, at least three Mexican Cretaceous fish localities are Konservat-Lagerstätten (e.g., Tlayúa, Vallecillos, El Chango). It is expected that the study of the Konservat-Lagerstätten will contribute to a sound understanding of the possible common ecological and chemical patterns that trigger the taphonomic processes involved in the origin of this extraordinary type of preservation.

A NEW GONORYNCHIFORM FISH FROM THE CENOMANIAN OF THE SIERRA MADRE FORMATION, CHIAPAS, MÉXICO

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The Cretaceous fossil record of the fishes belonging to the Order Gonorynchiformes in México began in 1996, when Applegate reported the occurrence of a large gonorynchiform species from the Albian Tlayúa Quarry, in Central México. The second discovery of gonorynchiforms in México occurred in 2008 when two new specimens were reported from the Cenomanian Sierra Madre Formation (El Chango Quarry, Chiapas State). These two specimens represent a new taxon, which we will describe here. This new taxon exhibits several diagnostic characters of the Ostariophysi and Gonorynchiformes, such as the absence of orbitosphenoid and basisphenoid, and the presence of laterally expanded supraneurals. The new fish shares with the Gonorynchidae a basibranchial tooth plate and cephalic ribs not attached to the shoulder girdle, and with members of Gonorynchus and Notogoneus, a unique V-shaped dentary. Since no caudal endoskeleton was preserved, we consider the assessment of its phylogenetic position premature and it is herein interpreted as a Gonorynchidae incertae sedis. This new taxon is the oldest record for the Gonorynchiformes in North/Central America and suggests an earlier split between the Quaternary/Recent and the Cretaceous Middle-East gonorynchids, related with the opening of the Mediterranean Tethys.

NEW JURASSIC TELEOSTS FROM THE UPPER JURASSIC OF BAVARIA, SOUTHERN GERMANY

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Although fossils from the Solnhofen Limestones have been known for over two centuries, the different quarries in the area of Bavaria are still sources of surprise because discoveries of new taxa are reported from time to time. New findings from the last ten years include a variety of fossil plants, invertebrates and vertebrates; with fishes being the most represented in number of taxa and specimens. While some of the recently reported new taxa were recovered in some of the oldest known localities such as Solenhofen and Eichstaett, many of the new findings are from more recently explored quarries such as Schamhaupten (Kimmeridgian) and Ettling (?Kimmeridgian).

The first fossil reported from Ettling was a small euteleost —Orthogonikleithrus hoelli— a species known only from this locality. This species was the only taxon known from Ettling for a long period of time. However, during the last few years, an interesting diversity that includes many different fish taxa has been uncovered at this locality. The new material includes beautifully preserved semionotiforms, amiiforms, pycnodontiforms, aspidorhynchiforms, ichthyodectiforms, crossognathiforms, and others.

The goal of this contribution is to communicate a new genus and species of basal teleosts that shows an overall similarity with the Upper Jurassic genus Ascalabos. Consequently, the neotype and additional specimens of Ascalabos are re-studied and compared with the new material from Ettling. Careful morphological studies of both the cranial and postcranial regions demonstrate outstanding differences between Ascalabos and the new genus and species. In addition, another new species of the euteleost genus Orthogonikleithrus is also described and compared to many new specimens of O. hoelli and O. leichi (from Zandt; Tithonian). This new material enormously increases the knowledge of certain structures such as the skull roof bones, infraorbital series, vertebral column, accessory neural arch, as well as other osteological features and gives a better understanding into the morphological characters of basal “true” teleosts, especially basal euteleosts.

ABOUT SOME REMARKABLE MORPHOLOGICAL CHARACTERS IN CERTAIN PACHYCORMIFORMS

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Pachycormiforms are characterized by some remarkable morphological characters that facilitate their identification as pachycormiforms. For instance: pectoral fin scythe-like, fin rays of the pectoral fins only segmented distally and bifurcating asymmetrically in an y-fashion, single uroneural-like elements developed from modification of neural arches of the preural region, and very small, special “rhombic” scales. In general, pachycormiforms are rare in museum collections and are usually poorly preserved making their description difficult and their knowledge incomplete. Consequently, the finding of some very well preserved specimens of Late Jurassic pachycormiforms is significant because it provides new information on certain morphological structures of these fishes.

In the present contribution the composition of the vertebral column and of the unpaired fins—especially certain structures of the caudal region as the uncommon bilateral expansions covering the bases of the caudal fin rays, and caudal fin rays and series of fulcra—and the special arrangement of the caudal fin scales of Orthocormus cornutus will be presented in detail. Very small scales cover the body of O. cornutus. However, a series of highly modified scales, of different sizes and following a characteristic arrangement, covers bilateral expansions of the base of the caudal fin. This special caudal structure is unknown from other actinopterygians. Additionally, the uncommon structure of the pectoral fin rays and fulcra of Strobilodus giganteus will be described. These features are compared, as far it is possible, with information in other pachycormiforms and other actinopterygians. The results show that many of these characters are very peculiar autapomorphies that make difficult any comparison with other actinopterygians.

A NEW CENOMANIAN MARINE FISH ASSEMBLAGE FROM SOUTHEASTERN MOROCCO

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The fossil Oued Sebaa locality situated 40 km S.-E. of Tafrout in southeastern Morocco was first discovered in 2000 by local citizens. The laminated fossiliferous limestone layer (80 cm thick) is restricted to the top of the Gara Sebaa mountain where it covers massive limestone strata. Up to now the microfauna is unknown from the fish-bearing layers. Probably the Oued Sebaa locality is either close or concur to the Agoult locality recently mentioned by Murray & Wilson (2009) and also belongs to the Akrabou Formation. The rich fauna of marine fossil fishes was sampled from the Oued Sebaa locality, and a representative set of specimens was transferred through the Stoneage s.r.l. company to the Natural History Museum of Verona. Preliminary observation of the fish assemblage from Oued Sebaa revealed the presence of at least 25 actinopterygian taxa, including a juvenile amiid, three different taxa of pycnodontiforms, macrosemiiform (either Agoultichthys chattertoni Murray & Wilson, 2009 or Petalopteryx sp.), Eubiodectis-like ichthyodectiform, Davichthys-like elopiform, Lebonichthys-like albuliform, ellimmichthyiforms Sorbinichthys cf. S. elusivo, Triplomystus sp. and at least three species of Armigatus and Diplomystus, incertae sedis clupeoid Scombroclupea sp., basal teleostean Gaudryella sp., eurypterygians Nematonotus sp., at least two species of Enchodus and two different taxa of Dercetidae, Eurypholis sp., Rharbichthys sp. and undescribed taxon of the Eurypterygii, perhaps distantly related to Yabrudichthys. Acanthomorph fishes are represented in the southwestern Moroccan fauna by diminutive specimens of two different taxa of Polymixiiformes and Hgulichthys-like beryciform. Characters of the matrix and preservation of the specimens make it difficult to identify many specimens, especially those of smaller size. Strong similarity of the Oued Sebaa fish association in familial and generic composition to the Cenomanian fish assemblages of the Lebanon and, in a lesser degree, to the Cenomanian locality Jebel Tselfat in Morocco, suggest the same age for the new locality. Until now, the ellimichthyiform fish genera Sorbinichthys and Triplomystus were recorded only in the Cenomanian Lebanese locality Nammoura (the latter genus recently was recovered also in Mexico).

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THE MESOZOIC RECORD OF CHONDRICHTHYANS FROM THE IBERIAN PENINSULA, WITH SPECIAL ATTENTION TO THE HYBODONTIFORMES

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During the last two decades the knowledge about Mesozoic chondrichthyans faunas in the Iberian Peninsula has increased considerably. Before this period, most of the publications dealing with Mesozoic sharks were scarce, anecdotic, and in most of them illustrations of the material are missing. In addition, the current location of this "old" material normally is uncertain, making the taxonomical revisions almost impossible.

There are recent synopses of the Mesozoic vertebrates of Spain, and there are also detailed synopses of the Mesozoic osteichthyan fishes in Spain, but there are no meticulous synopses dealing with Mesozoic chondrichthyans in Spain and Portugal.

Chondricthyans are present in the Triassic, Jurassic, and Cretaceous sediments, in continental, transitional, and marine environments. The highest diversity has been found in the marine sediments of the Upper Cretaceous, but this high diversity is probably due, at least in part, to a more intensified work in these sediments. The diversity of chondrichthyans in Lower Cretaceous sediments has steadily increased during last years. The studies of Jurassic and Triassic chondrichthyans are still in an early stage of development.

Most of the Mesozoic chondrichthyan assemblages from the Iberian Peninsula are composed exclusively by isolated elements, usually teeth, but in some cases other elements, as vertebrae, fin spines and cephalic spines have been found. The El Montsec site (Santa María de Meiá) is a rare exception in the Iberian record of chondrichthyans, being the only locality with undisturbed articulated specimens.

Three new localities have recently yielded hybodontiform sharks from the Upper Jurassic-Lower Cretaceous of Northern Spain, namely from the Upper Jurassic of Asturias, and from the Lower Cretaceous of the Basque-Cantabrian and Cameros Basins. Among these, the most unexpectedly rich assemblages (in diversity and high number of teeth) have been recovered in the Lower Cretaceous of the Enciso Group (Aptian), in the Cameros Basin. At least six different genera of hybodontiform sharks are recorded (Lonchidion, Lissodus, Parvodus, Hybodus, Planohybodus, and Egertonodus).

A NEW SEMIONOTIFORM FROM THE UPPER JURASSIC OF SPAIN

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Despite the abundance of isolated remains, normally scales assessed to Lepidotes sp., articulated fishes were unknown in the Jurassic of Spain. Here we present a new specimen of semionotiform from the Tithonian of the Cameros Basin.

The specimen comes from the proximity of San Andrés de San Pedro, province of Soria, Spain. Geologically, it is located in the Sierra de Matute Formation (Tera Group), in the southeastern part of the Cameros Basin. The sedimentary record of the Cameros basin ranges from the Tithonian to the early Albian, and consists of continental sediments (alluvial and lacustrine systems) with occasional traces of marine incursions. The palaeoenvironment of the Matute Formation is interpreted as lacustrine-palustrine, and the age of the beds that provided the fish, upper Tithonian.

The new specimen is articulated and three-dimensional; it consists of the skull plus the anterior part of the body in lateral view. Although initially not very promising, due to the apparently poor preservation of the exposed parts, preparation has revealed a number of unexpectedly fine anatomic details. The dermal bones are ornamented with tubercles. The snout is moderately elongated; both the maxilla and the mandible are short and posteriorly deep. The teeth are small but robust, with a high hemispheric to conical crown and a very long base. There are two complete series of bones around the orbit: one of many infraorbitals, a number of which are deep and placed anterior to the orbit; and one of large, low suborbitals that separate completely the infraorbitals from the preopercular bone. Only two scales from the dorsal ridge are preserved; these are “small scales” sensu Olsen et al. (1982), with short spines. These “small scales” are covered by ganoine all over, except on the area surrounding the base of the spine.

The record of articulated Lepidotes from Spain is scarce and so far limited to the Early Cretaceous: Lepidotes ilergetis and Lepidotes sp., from El Montsec (Lérida), and L. microrhis and L. tanyrhis from Las Hoyas (Cuenca). The new specimen presents more affinities with other Jurassic to Early Cretaceous species from Europe (e.g., Lepidotes mantelli, L. semiserratus) than with the Spanish Early Cretaceous taxa, for instance, the type of dentition, the shape of the snout, and the number and arrangement of infraorbital and suborbital bones. This new specimen is especially relevant, as it represents the first articulated fish material reported from the Jurassic of Spain.

MESOZOIC FISHES FROM AUSTRALIA

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The origin of Australia's modern fish fauna is problematic, as clades represented in the fossil record are either extinct or belong to unrelated taxa. Currently, the study of some of the phylogenetic and palaeobiogeographic processes that would have regulated the composition of the Australian palaeoicthyofauna, particularly within the context of unique geographic and climatic conditions, is still pending. Over twenty Mesozoic fish localities have been recognized within Australia, with the vast majority being marine.

Early-Late Triassic fish localities are widespread in four main areas: the Knocklofty Ranges, near Hobart, Tasmania (Knocklofty Formation); St Peters, Brookvale and Gosford in the Sydney Basin (Ashfield Shale, Hawkesbury Sandstone and Gosford Formation, respectively); the Erskine Ranges, northern Western Australia (Blina Shale); Rolleston and Bluff, southern Queensland ('The Crater', Duckworth Creek and Rewan; Arcadia and Rewan Formations). Jurassic localities occur in the Surat Basin in southern Queensland (e.g, Balgowan Colliery, Darling Downs; Walloon Coal Measures) and northern NSW (Talbragar Fish Bed, Gulgong; Purlawaugh Formation); the Clarence-Moreton and Mulgildie Basins, south-eastern Queensland (Walloon Coal Measures and Hutton Sandstone, respectively). Cretaceous localities are known from Koonwarra, near Melbourne, Victoria (Lower Cretaceous Korumburra Group), and the Eromanga Basin, central-western Queensland (Lower-"mid" Cretaceous Allaru Mudstone, Winton and Toolebuc Formations).

The Mesozoic Australian fish assemblage includes many different Triassic and Cretaceous lungfishes (ie. Ptychoceratodus phillipsi), along with diverse Triassic actinopterygians (Cleithrolepis and Saurichthys). Fishes from the Kimmeridgian Talbragar Bed are the best preserved Jurassic fishes known from Australia, and include Cavenderichthys talbragarensis (originally described as Leptolepis talbragarensis). Cretaceous actinopterygians include Aspidorhynchidae, Cladocyclus, Lepisosteidae, Pachycormiformes, and Pachyrhizodus, all of which are also found in other parts of Gondwana and Laurasia, thereby indicating faunal interchange with these regions during the Cretaceous.

ELOPIFORMS: NEW, LARGE ELOPOIDS FROM THE CRETACEOUS AND EARLY TERTIARY

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Elopoids to day – considered one or more often two families, Elopidae and Megalopidae (ten pounders or lady fishes and tarpons) – grow to quite a large size. The Atlantic tarpon Megalops [or Tarpon] atlanticus, is a popular game fish reaching about 2 m in length and weight 160 kg. M. cyprinoides from the Indo-Pacific, the Pacific tarpon, reaches over one meter, while some of the seven species of Elops reach about one meter in length.

The Mesozoic members are usually much smaller, most of the Late Jurassic and Cretaceous forms reaching no more than 20 to 30 cm as described by Arratia and Forey respectively. Although the living species of these primitive teleosteans are not rare as marine, coastal fishes, some go also into river mouths and freshwater. The Tertiary fossil record is rather poor. The richest occurrences are of Eocene age, but even so some of the most famous marine fish beds and localities like Monte Bolca (Middle Eocene) and Danatinsk Formation of Turkmenistan (Early Eocene) of the Tethys Region have produced no elopoids.

Only the 'North Sea Region' has a certain diversity of elopoids in the late Early Eocene, as collected in the phosphatic concretions of the London Clay, in which mainly the skulls alone are preserved in 3-D, and often only the braincases. London Clay contains an 'Elops sp.' with skull bigger than the living species, and 4 (or 5?) species of two genera, Protarpon and Promegalops, both megalopids. The largest skull of Protarpon is about 30 cm long, corresponding to a total length of 120 –125 cm. Promegalops as estimated from a 20 cm skull had a length of ca. 80 cm.

In the Danish 'Mo-clay' (Fur Fm.) of lowermost Eocene 'tarpon' scales are very common, and a complete fish 115 cm long was recently found (skull in 3-D ca. 25 cm long, acid prepared – evaluated as 'danekrae'). Large, isolated scales indicate fishes at least twice as long. This fish appears to be the most complete elopoid known from the Tertiary, although the postcranial skeleton is also known from the Late Eocene Lyrolepis from Caucasia, which also grows to a fair size as estimated from the rather 'tarpon-like' scales.

In the Early Cretaceous (Albian) of Tlayúa, southern Puebla, México there are many small 'elopiform-like' fishes according to Applegate, but in 2009 a large, meter long, complete megalopid-like fish was collected, probably the same taxon as the single fish called 'Megalops-like sp. A' by Applegate.

These large Eocene and Cretaceous elopoids will be illustrated though not yet analysed concerning their precise interrelationships. The Tlayúa fossils will be described in co-work with J. Alvarado-Ortega.

LAMPRIDIFORMES OF THE CRETACEOUS AND PALEOGENE
A PRELIMINARY PRESENTATION

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The Lampridiformes is a small group of highly specialized teleosteans of very diverse appearances comprising to day a score of species in 12 genera and 7 families. Despite their specialisations they retain a "primitive" position within Acanthomorpha as probably the sistergroup of all the other included groups. With some of these like Polymixiiformes and Beryciformes well represented among "mid" Cretaceous fossils (formally Cenomanian, earliest Late Cretaceous), one would expect lampridiforms of at least the same age, but such have not (yet) been described, unless one believes the weak indications, that Aipichthys (and close Cenomanian relatives) might be these primitive lampridiforms. Only fairly recently a convincing lampridiform has been described from the Upper Cretaceous (Campanian/Maastrichtian) of Italy.

To the Cretaceous record should probably be added three Cenomanian ones from Lebanon. Two are very deep-bodied ones, which were figured by Gayet et al. in 2003, but not described [one fossil is 13 cm long with about 35 vertebrae and the second one is15 cm with ca. 50 vertebrae (same form 8 cm long figured in Frickhinger’s Atlas in 1991 as Beryciformes?)]. The third taxa is possibly an only 2 cm long, more shallow bodied fish that was acid prepared in the 1970-ies by M. Gayet (but apparently undescribed) with a dorsal fin similar to the very peculiar one in Palaeocentrotus.

In contrast, the record from the Paleogene is surprisingly rich, especially in the Eocene with 12-13 genera (three or four? undescribed), and there is one in the Danian, and one in the Oligocene. The earliest modern genus is Lampris from the Miocene of California. Other records include: Danian, Scania and Denmark Bathysoma; Earliest Eocene, Fur Formation, Denmark: Palaeocentrotus, cf. Analectis and a new genus. Same age, Turkmenistan: Turkmene, Danatinia; Early Eocene, London Clay: Whitephippus, Goniocranion; Middle Eocene, Monte Bolca: Veronavelifer, Bajaichthys, “Pegasus” volans (the earliest elongate one, somewhat Stolephorus like); Late Eocene (formerly Oligocene), Iran: Protolophotus; Oligocene, Caucasia: Analectis.

A phylogenetic analysis of the many fossils has not yet been performed, but it is clear that also the fossil record tells, that a rather deep body is the plesiomorph habitus 100 m. y. ago, rather like Velifer – the earliest very slim and elongate form from middle Eocene, about 50 m. y.

EOCENE, MARINE OSTEOGLOSSOMORPHS AND IMPLICATIONS FOR THE DISTRIBUTION OF THIS GROUP IN THE CRETACEOUS

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Living osteoglossids and for that matter all Osteoglossi (new crown group taxon comprising Mormyriformes and Osteoglossiformes) have traditionally been considered prime examples of primary freshwater fishes. In the marine Eocene one osteoglossid like fish has been recognized (Brychaetus) in the Eocene London Clay, and it could be considered an 'anomaly'. But by now 9 more marine Eocene forms have been found. Six were described from the earliest Eocene of Denmark, where two new genera (Heterosteoglossum and Xosteoglossid) occur with Brychaetus in basal Eocene, and the former is found also in the overlying 'Mo-clay' (Fur Fm.) together with three more genera. Most common is Heterosteoglossum (which is also identified in basal London Clay). Opsithrissops from Turkmenistan has the same age, and three marine forms (Monopteros, Trissopterus, Foreyichthys) occur in Monte Bolca.

Analyses of the phylogenetic relationships of marine osteoglossomorphs shows that these genera are distributed in different positions in the tree, none of them appear to be closest relatives of each other. The most primitive is Furichthys, probably high in the stemgroup of Osteoglossi, while Brychaetoides is basal in the stemgroup of Osteoglossiformes. Xosteoglossid has a very high position in this stemgroup or is inside the living crowngroup. The arapaimid subgroup of this crowngroup has Trissopterus low in its stemgroup, while the osteologlossid subgroup has Opsithrissops, Brychaetus, Foreyichthys and Heterosteoglossum as successively more advanced members of its stemgroup. Arapaimids and osteoglossids clearly had a marine last common ancestor, and the last common ancestor of Osteoglossi was probably also marine, indicating mormyriform origin in the sea. The entire Osteoglossomorpha had a marine origin. So the hiodontids must be another independant invasion into freshwater. Accordingly, there must have been a number of Cretaceous, marine 'stemforms' of that group, the Mormyriformes and probably arapaimids, while osteoglossids might be a younger lineage. Where did these 'missing Cretaceous ancestors of hiodonts, mormyriforms, arapaimids and perhaps osteoglossids live? May be in the sea surrounding the mythical 'Pacifica' and now subducted, and with 'stem-mormyrifoms' in the Indian Ocean. Now these expected marine osteoglossomorphs may have turned up as tiny somewhat 'Lycoptera-like' fishes from Early Cretaceous in Tlayúa, México. They seem to be very primitive within the group, quite likely sistergroup of all the rest, as they have retained some 'elopiform-like' features otherwise lost in osteoglossomorphs.

NON-MARINE ACTINOPTERYGIAN FISH ASSEMBLAGES FROM THE UPPER CRETACEOUS OF THE WESTERN INTERIOR OF NORTH AMERICA – EVIDENCE FROM VERTEBRATE MICROFOSSIL LOCALITIES

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Non-marine fish assemblages from the Upper Cretaceous of the Western Interior of North America have traditionally been regarded as being dominated by basal actinopterygians. However this is likely a bias resulting from the ease with which isolated elements of these fish can be identified. Teleosts are often abundant but are represented primarily by isolated elements. In order to better understand the diversity, distribution and biostratigraphy of non-marine actinopterygians in the Western Interior during the Late Cretaceous a study of isolated fish elements from vertebrate microfossil sites was undertaken. Localities from Utah, Montana, and Alberta were examined. Together the sites from these regions document nine stratigraphic intervals extending from the Cenomanian to the latest Maastrichtian. Sample sizes are typically very large, generally numbering in the thousands of elements.

Cenomanian fish assemblages are dominated by pycnodonts, amiids, and Lepidotes but at least seven kinds of teleosts are also present, including an elopomorph, an osteoglossomorph, and a hiodontid. The teleosts are all of very small body size. A major faunal change occurs between the Cenomanian and Turonian, marked by decreased abundance of pycnodonts and Lepidotes and the first occurrence of Lepisosteus, the amiid subfamily Vidalamiinae, and an indeterminated ostariophysan with possible relationships to catfish. Acanthomorphs first occur in the Coniacian, esocoids first occur in the late Santonian, and Paralbula first occurs in the mid-Campanian. Teleosts of moderate to large body size first occur in mid-Campanian localities, and larger-bodied teleosts are more abundant in the Campanian and Maastrichtian.

Latitudinal patterns are identified by comparing late Campanian assemblages from Utah and Alberta. The vidalamine and the indeterminate ostariophysan are dominate members of southern assemblages and rare or absent in northern localities, while the semionotiform designated Holostean A and the osteoglossomorph Coriops are abundant in northern regions. Changes in abundance of these fish through the Upper Cretaceous in Alberta are related to changes in climate.

THE IMPORTANCE OF THE FOSSIL FISHES FROM THE LOWER CRETACEOUS OF BRAZIL

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The history of the Cretaceous ichthyofaunal biodiversity in Brazil is very well documented, particularly in the Aptian/Albian stages. Fossil vertebrates are especially abundant from the Crato and Santana formations of northeast Brazil. Fossils from these formations are world famous because they are commonly preserved as articulated and three dimensional specimens. This fauna represents an important period of time where a widespread epicontinental sea extended southward from the shallow waters of the Caribbean Tethys onto the South American continent and, as new evidence is revealing, some affinities at the generic level (e.g., Vinctifer, Araripichthys) with "mid"-Cretaceous (Aptian/Albian) marine ichthyofaunas from México and North Africa. However, this fauna also includes elements such as Dastilbe and Santanichthys that are interpreted as being freshwater in origin. A comparison of this fauna with the youngest Bauru Group fish assemblage (Campanian/ Maastrichtian) in Southeastern Brazil shows no common elements. Although not very well preserved and consequently not very well known, the fauna of the Upper Cretaceous possibly represents the origin of the Neotropical fauna, with numerous disarticulated remains of osteoglossomorphs, siluriforms and characiforms.

A NEW NOTOPTERID (TELEOSTEI, OSTEOGLOSSOMORPHA) FROM THE UPPER CRETACEOUS KEM KEM BEDS, MOROCCO

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A new notopterid is described based on a single specimen from the Upper Cretaceous Kem Kem beds of Morocco. The specimen is preserved as an articulated skull and parts of the postcranial skeleton. Features of the skull, such as the presence of a basisphenoid, triangular shape of dermosphenotic, post-temporal fossae limited by the epiotic, exoccipital, and pterotic, ventral part of the preopercle not reaching the level of the orbit, as well as the number of branchiostegals suggest that, within the notopterids, this new taxon seems to be closely related to the extant genus Chitala. Fossil notopterids are scarce and known only by the articulated taxon, †Notopterus primavus (= N. notopterus) from the Sankarewang Formation, Eocene of Sumatra and the otolith “Notopteridarium” nolfi from the ?Paleocene of Andhra Pradesh, India; †Palaeonotopterus greenwoodi, from the same locality of the new species, had been originally described as a Notopteridae; however recent studies reinterpreted it as a non notopterid osteoglossomorph.

POSSIBLE ECOLOGICAL ASSOCIATION BETWEEN SEMIONOTIFORM FISHES AND SPINOSAURIDS DINOSAURS

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Spinosaurids are Late Jurassic - Cretaceous theropod dinosaurs with a diet specialized at least partially on fish. Evidence supporting this assumption are anatomical features related to ichthyophagy, taphonomic associations between fish remains and spinosaur skeletons, and geochemical signal from spinosaur teeth indicating an aquatic mode of life. Acid-etched scales and teeth referred to Lepidotes mantelli were found in the smashed-up rib-cage of the holotype specimen of Baryonyx walkeri. A preliminary survey of most, if not all, localities which have yielded spinosaur bones and teeth contain also associated semionotiform remains. Here, we review published occurrences of spinosaurids and associated semionotiforms, and discuss the likelihood of ecological association between both taxa. The oldest known occurrence of spinosaurids includes isolated teeth referred to a baryonychine from the Upper Jurassic of Tendaguru, Tanzania, which has also yielded a freshwater semionotiform fish. In Africa, the 'Continental Intercalaire' is a thick series of continental deposits ranging from the basal Cretaceous to the early Upper Cretaceous. Several Formations from the 'Continental Intercalaire' have yielded spinosaurid remains together with semionotiform remains. In South America, spinosaurines and semionotiforms have been described from the ?Albian Santana Formation, Brazil. Early Upper Cretaceous Formations in Brazil (Alcântara Fm.) and in Argentina (Cerro Lisandro Fm.) have also yielded remains of both taxa, but these are still poorly known. In Europe, the couple Baryonyx walkeri / Lepidotes mantelli was described from the Early Barremian of UK, and isolated baryonycine teeth and semionotiform scales and teeth have also been found in several localities from UK, ranging from the Hauterivian to the Barremian. In Spain and Portugal, several localities, mainly Barremian in age, have yielded spinosaurids teeth, sometimes in association with semionotiform remains. Several Early Cretaceous Formations in Asia (China, Japan and Thailand) also contain spinosaurid and semionotiform remains. The regular association between spinosaurid and semionotiform remains in Western Gondwana (Africa and South America), Europe and Asia, indicate a possible ecological link between both taxa (spinosaurids used to prey on semionotiforms). If such an association really occurred, we could expect that the palaeobiogeographical signals of both lineages should show a similar pattern.

THE LATE HAUTERIVIAN (EARLY CRETACEOUS) FISH ASSEMBLAGE FROM THE MOUNTAIN OF VOIRONS, HAUTE-SAVOIE, FRANCE

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François-Jules Pictet de la Rive described in 1858 a Neocomian fish assemblage from the locality of Hivernanches in the Mountain of Voirons, Haute-Savoie, France. The taxa from that locality have been often mentioned in the fossil fish literature but, as far as we know, the original specimens kept in the Natural History Museum of Geneva have never been re-studied. Here we propose a preliminary revision of the taxa present in this locality. We identified the following taxa: Belonostomus (= 'Aspidorhynchus') genevensis, Crossognathus sabaudianus, Chirocentrites (= 'Spathodactylus') neocomiensis, indeterminate orthogonicleithrids (corresponding in part to 'Clupea antiqua' and to 'C. Voironensis' from Pictet), as well as two indeterminate teleosts. Based on this revision, 'Crossognathus sabaudianus' from Helgoland, Germany, and from Vallentigny, France, should be referred to the taxon Crossognathus albiensis.

Fieldtrips conducted in 2007 and 2008 in the Mountain of Voirons have not permitted to find again the fossiliferous locality.

CATFISH DIVERSITY IN THE CRETACEOUS OF SOUTH AMERICA

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The Siluriformes (catfishes) constitutes an important monophyletic ostariophysan group of mainly freshwater fishes that occurs in almost all continents. Catfishes are presently distributed in tropical to temperate areas and a small number of species is marine or amphibiotic. Siluriforms (catfishes) constitute one of the most diverse vertebrate groups both morphologically and taxonomically. Presently, there are about 35 families with almost 3,500 species in all continents except Antarctica. However, they occur in Eocene beds of Antarctica.

Siluriformes are extremely abundant and diverse in South America, where the oldest putative otophysans and siluriforms occur. The most primitive living catfish is the family Diplomystidae of Patagonia and central and southern Chile. The oldest known fossils assignable to Siluriformes occur in the Campanian (Late Cretaceous) of southern South America which is the only continent where catfishes are common in Cretaceous rocks (Argentina, Bolivia, and Brazil). The only extra-South American Cretaceous records are otoliths and a few spines from North America and one spine from India and another from Madagascar. However, most of the South American Siluriformes are still undescribed.

The early evolution of the catfishes is very poorly known. The putative sister group is Gymnotiformes (or Gymnotoidei), a group of South American endemics with only one fossil record in the Miocene of Bolivia. The oldest catfishes present typical autapomorphies of the group (e.g. the typical pectoral and dorsal spines, the pectoral girdle). Certainly, it had to have been episodes of diversification in South America. Lineage-splitting should have been coupled with many independent evolutionary experiments and ecological specializations.

In this paper, we describe the Cretaceous South American catfish fossils from Argentina and comment on the records from Brazil and Bolivia. The fossil evidence shows that catfishes were morphologically diversified in the Cretaceous indicating an early cladogenesis of the group in the continent.

A SPECIES OF THE AUSTRALIAN LUNGFISH GENUS METACERATODUS IN UPPER CRETACEOUS BEDS OF SOUTH AMERICA

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Four species of the ceratodontid lungfish genus Metaceratodus (M. ellioti, M. bonei, M. wollastoni) were described in Australia from sediments that range from the Lower Cretaceous to Pleistocene. These species were identified with isolated plates, some joined to splenial and prearticular bones. Other authors have suggested that the species Metaceratodus wollastoni could be present in South America. Here we confirm the occurrence of specimens of Metaceratodus from Upper Cretaceous beds of northern Patagonia (provinces of Río Negro and Neuquén) and Cuyo (province of Mendoza), Argentina. However, we do not agree in recognizing an Australian species in South America but a different one. We used many isolated tooth plates and several others attached to bone and different ontogenetic stages. Metaceratodus shares with Ceratodus broad and flat tooth plates, which present robust ridges originated anteriorly (not medially). However, they differ from those of Ceratodus because Metaceratodus presents double prearticular sulcus (not single). Besides, Ceratodus appears to be a boreal genus. The Patagonian material we here describe presents the Metaceratodus character. The occurrence of Metaceratodus in the South American Upper Cretaceous confirms the existence of fresh water basin connection between both continents by means of Antarctica during the Cretaceous. This continental connection is also confirmed by other organisms as well as by tectonic evidence.

PARTIAL SKELETAL REMAINS OF ARCHAEOLAMNA KOPINGENSIS (LAMNIFORMES) FROM THE UPPER CRETACEOUS PIERRE SHALE OF WESTERN KANSAS

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Previous descriptions of the lamniform shark Archaeolamna kopingensis consisted only of isolated teeth. The recovery of a partial skeleton from the Sharon Springs Formation of the Pierre Shale Group of western Kansas provides insight into its systematic position among the lamniforms. The remains include a portion of the neurocranium and multiple vertebral centra. As well, portions of the palatoquadrate and Meckel's cartilage with articulated teeth are preserved. The jaws preserved distinct dental bullae which contain two rows of upper and lower anterior teeth and a single row of intrabullar intermediate teeth of unique morphology. The upper intrabullar intermediate teeth have a median cusp with the apical half forming a very strong distal curvature. These teeth are shorter than the first and second upper anterior teeth in total tooth height, but it is approximately equal in stature when accounting for cusp slant. Also preserved are four symphysial teeth and multiple rows of lateral teeth. The tooth morphology and dental series of A. kopingensis is distinct from Cretoxyrhina, Cretalamna, Cardabiodon, and all other lamniforms validating its placement into a distinct family, the previously proposed Archaeolamnidae. We conclude that the family Archaeolamnidae should be diagnosed by the following characters: (1) the presence of reduced first lower anterior teeth; (2) the presence of two rows of anterior and one row of intrabullar intermediate teeth within the dental bullae; (3) the first upper anterior teeth equal the second upper anterior teeth in height; (4) the presence of enlarged upper intrabullar intermediate teeth with a distinctive distal curvature of the median cusp; and (5) the lack of reduced extrabullar intermediate teeth and an intermediate bar. The tooth morphology and large jaw circumference suggest that this shark likely preyed upon large prey items.

A NEW SPECIES OF HETEROPTYCHODUS (ELASMOBRANCHII: HYBODONTIFORMES) FROM THE LOWER CRETACEOUS OF THAILAND

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A new species of the hybodont shark Heteroptychodus is described from the Lower Cretaceous Sao Khua Formation in Thailand. It is the third species assigned to this genus so far endemic to the Lower Cretaceous of Asia. The two first species are Heteroptychodus steinmanni from the Lower Cretaceous of Thailand and Japan and H. chuvalovi from the Lower Cretaceous of Mongolia and Kyrgystan. The new species is characterized by mesio-distally elongated lateral teeth, a character shared with H. chuvalovi, and a specific ornamentation pattern.

Detailed study of the teeth of H. steinmanni from Thailand revealed lozenge-shaped anterior teeth, suggesting that the anterior teeth formed a pavement similar to that can be seen in a dasyatid ray. No evidence of such an arrangement is to be found in the lateral teeth of this species though. So far no lozenge-shaped teeth have been recovered in the two other species of Heteroptychodus.

This new study demonstrates a different heterodonty pattern between Ptychodus and Heteroptychodus, so that the attribution of the latter to the family Ptychodontidae is not really sustained.

AN OVERVIEW OF THE ?LATE JURASSIC FISH FAUNA FROM THE MISSÃO VELHA FORMATION (ARARIPE BASIN, NORTHEASTERN BRAZIL)

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The Araripe Basin is one of the richest fossiliferous localities in the world. This Basin is divided into two distinct stratigraphic groups: the Vale do Cariri Group (constituted by the Cariri, Missão Velha and Rio Batateiras formations) and the Araripe Group (composed of the Crato, Ipubi, Santana and Exú formations). Many papers dealt with the fossils of the Crato and Santana formations; however, very few studies treated the paleobiota of the Vale do Cariri Group. In the present work we will describe the paleoichthyofauna of the Missão Velha Formation. This fauna is very important because it probably represents an ?Oxfordian, lacustrine biota, deposited during the pre-rift/rift stages of the breakup of western Gondwana. Although disarticulated, we can identify the presence of five fish taxa (Hybodus sp., Lepidotes sp., a pleuropholid, a mawsonid coelacanth, and Neoceratodus sp.) as well as fragments of at least three teleost taxa.

FOSSILS OF THE FAMILY KNERIIDAE (TELEOSTEI: GONORYNCHIFORMES) FROM THE EOCENE LAKE OF MAHENGE (TANZANIA)

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In this contribution we report the first fossil kneriid gonorynchiform recovered in Africa or worldwide. Extant Gonorynchiformes comprise two marine (Chanidae and Gonorynchidae) and two freshwater (Kneriidae, and Phractolaemidae) families. Kneriid gonorynchiforms inhabit freshwater systems of sub-Saharan Africa, with two genera in the family, Cromeria and Grasseichthys, currently interpreted as paedomorphic or miniaturized genera. Interrelationships of the family Kneriidae have been controversial as a result of the difficulty in estimating the phylogenetic position of the miniaturized taxa, as they possess a number of morphological features that are reductive and plesiomorphic. The fossil kneriid material is represented by complete specimens that provide critical information on kneriid vertebral centra and ribs, as well as other postcranial and cranial elements important to our understanding of miniaturization. Inclusion of this fossil in systematic analysis of gonorynchiform fishes furthers our understanding of the evolutionary relationships of the family Kneriidae, and the evolution of miniaturization in the clade. With this new information the fossil record of gonorynchiforms is now known from the following three families; Chanidae (Early Cretaceous), Gonorynchidae (late Early Cretaceous), and the much younger Kneriidae (Eocene). Gonorynchiform distribution in the fossil record corresponds with the currently recognized phylogenetic position of Kneriidae as the most derived group of gonorhynchiform fishes, and this fossil taxon is recovered as the basal kneriid lineage in our phylogenetic analysis.

A NEW SEMIONOTIFORM FISH (ACTINOPTERYGII, NEOPTERYGII) FROM THE PHU KRADUNG FORMATION (UPPER JURASSIC-LOWER CRETACEOUS) OF NORTHEASTERN THAILAND

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The Khorat group is a pack of continental sediments located in NE Thailand and comprising five formations ranging in age from the Upper Jurassic to the Aptian (Lower Cretaceous). Three of these formations have yielded very rich vertebrate assemblages. Fossils of bony fish are abundant as isolated remains in most of the fossiliferous localities, and as articulated specimens in some localities, such as Phu Nam Jun, Kalasin province. The most common fish remains belong to semionotid-like neopterygians.

Here, we describe a new sub articulated semionotid-like fish collected in greenish gray mudstones of the Phu Kradung Formation at the Phu Noi locality (Kam Muang district, Kalasin province). The deposit is Upper Jurassic or basal Cretaceous in age. The single known specimen lay underneath an accumulation of dinosaur bones.

The specimen shares with Isanichthys palustris, described from the Phu Nam Jun locality, a rather similar pattern of ossifications of the opercular and circumorbital series, in particular an anterior supraorbital lying above an anterior infraorbital, which has no contact with the orbit. However, it differs from I. palustris by the occurrence of a single sensory canal on the dentary and by the presence of conspicuous dorsal ridge scales (two characters also present in the contemporaneous Lepidotes buddhabutrensis). Moreover, the specimen shows distinct characters such as the occurrence of tiny crushing teeth on the vomer.

This preliminary description indicates that this specimen should be included in a new taxon, and strengthens again the morphological diversity of the 'semionotiforms'. Understanding the phylogenetic relationships between the Late Jurassic and the Cretaceous 'semionotiforms' is an important goal for future studies.

THE ICHTHYOFAUNA FROM THE UPPER CRETACEOUS LOCALITY VALLECILLO (NORTHEASTERN MÉXICO) – AN UPDATE

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The Upper Cenomanian to Lower Turonian (Upper Cretaceous) Lagerstätte Vallecillo (Nuevo León, México) is known for its abundant and well-preserved fossil fishes. Most fossils were randomly collected by the quarrymen and scientists while screening spoil heaps and outcrops in the quarry area. Additionally, ten scientific layer by layer excavations have unearthed plenty of specimens, which provide quantitative data about absolute abundance and distribution of the fossils. Until now, about 900 fish specimens were examined. The fish assemblage shows a low diversity compared to coastal and non-marine Plattenkalk-localities. However, the results of ongoing preparatory work are steadily increasing the number of taxa and help to clarify the systematic position and the phylogenetic relationship of already known taxa. Furthermore, the new data help to elucidate the palaeobiogeographical relationships of the fauna.

For example, the recent discovery of a predentary bone in the ichthyodectiform Vallecillichthys multivertebratum Blanco & Cavin, 2003, indicates that this taxon is nested within the saurodontids. Additionally, the discovery of Gillicus arcuatus (Cope), 1875 and a small ichthyodectiform, that shows a close relationship to Heckelichthys, indicates that there are at least three different ichthyodectiform genera within the Vallecillo assemblage.

Within the pachyrhizodontoids, remains of Pachyrhizodus caninus Cope, 1872 and, more recently, Tingitanichthys were discovered. The latter, together with Belonostomus, Nursallia, Tselfatia, Rhynchodercetis and Heckelichthys indicates that the Vallecillo-Fauna shares at least six genera with the Cenomanian fish-fauna from Djebel Tselfat in Morocco. This indicates a strong vicariance event between Western and Central Tethys during the Upper Cretaceous.

PTYCHODONTID SHARKS FROM THE UPPER CRETACEOUS LOCALITY VALLECILLO (NORTH-EASTERN MÉXICO)

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Little is known about the Cretaceous shark Ptychodus although teeth are abundant in Upper Cretaceous marine deposits worldwide. It is generally assumed that Ptychodus is a hybodontid due to similarities with the dentition of other hybodontids. However, the evidence of some calcified vertebrae found in association with ptychodontid dentitions from the Niobrara Formation (Kansas, U.S.A.) questions this assumption and suggests that Ptychodus is a neoselachian, as are all modern sharks and rays.

Recently, three specimens of Ptychodus decurrens (UANL-FCT-VC-723, CPC-427, CPC-437) were collected from the Lower Turonian platy limestone locality at Vallecillo (Nuevo León). They show both dentition and soft parts aligned with elements of the cranial and postcranial skeleton. Although incomplete, the specimens provide new information that elucidates details of the anatomy, systematics and paleobiology of ptychodontids. Amongst other things, the complete calcification of the vertebrae of the Vallecillo specimens indicates that ptychodontids are in fact neoselachians. The preserved calcified cartilaginous structures in the skull region confirm an early reconstruction of the mandible of Ptychodus decurrenby Woodward in 1904. Furthermore, these cartilaginous structures indicate that Ptychodus decurrens had a broad head with a short snout. The preserved skin patches contain placoid scales in situ. This yields information about the placoid scale variability within an individual of Ptychodus decurrens. For example, the morphology of the placoid scales of the trunk shows similarities to the scales observed in extant fast swimming pelagic sharks. The preserved postcranial soft parts will allow for a reconstruction of the body shape and proportions of this animal.

PREPARATION OF FOSSIL FISHES FROM VALLECILLO - IMPROVED METHOD ALLOWS FOR DETAILED ANATOMICAL STUDIES

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The Lower Turonian (Upper Cretaceous) Lagerstätte at Vallecillo (Nuevo León, México) is known for its abundant and well-preserved fossil fishes. Bones are generally re-crystallized and diagenetically replaced by calcite in the platy marls and limestone of this locality, which causes problems for the recovery and preparation of the fossils. This process creates a problem whereby sutures between bones are often invisible. In addition, the coarse-grained calcite is densely interlocked with the grains of the adjacent sediment.

The consequences are:

A) True separation surfaces between bone and sediment are absent. Consequently, most fossils rupture along their median plane when the quarry workers split the slabs. Thus, both slabs contain half a fish skeleton.

B) After recovery, many bones are broken and anatomical details of their external surface are hidden within the sediment.

C) Because the chemical properties of bone and sediment are equal, it is impossible to use acid preparation. Treatments with resin are also impossible because of the high porosity of both bones and sediment.

A preparation method, which achieves good results, has been demonstrated on a complete, but heavily crushed, specimen of an ichthyodectiform, Vallecillichthys multivertebratum. The skeleton was split along its median plane. To enhance the quality of the fossil, all parts had to be reassembled on one slab. Therefore the bone fragments containing parts of the counter-slab were hardened and glued back on the main slab in their original position. Sediment of the reglued parts of the counter-slab was then carefully removed mechanically with scalpels and steel needles, as the vibration of an air scribe would have caused damage. After this preparation, the specimen is the first that allows the study of the entire vertebral column, of fins including the caudal one, and a whole reconstruction of this ichthyodectiform. Additionally, this method is suitable for liberating three-dimensional preserved specimens found in Vallecillo from their surrounding matrix.

“PHOLIDOPHORIFORMS” OF LA CANTERA FORMATION, LOWER CRETACEOUS, SAN LUIS, ARGENTINA

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La Cantera Formation is a lacustrine fossiliferous unit that is dated Late Aptian based on its palinological content. It is located in “Sierra de El Gigante”, San Luis, in the center west of Argentina. It has provided a very rich fossiliferous content including plants, palynomorphs, insects, crustaceans, and fishes that constitute a very diverse biological association. Fishes from La Cantera are the only vertebrates that have been recorded in this site until now. They are small-sized (approximately from 5 to 15 cm length) and represent two groups of Actinopterygii. These are: 1) chondrosteans, which are the most abundant fishes in this deposit, and (2) neopterygians. The neopterygians have been preliminarily interpreted as “pholidophoriforms” based mainly on their small size and the presence of scales and bones covered with ganoine. In addition to these generalized characters, the specimens present basal and long fringing fulcra in the paired fins and a hemiheterocercal caudal fin with epaxial basal fulcra preceding a series of elongated fringing fulcra. Although the generalized morphology that it makes difficult the identification of the fishes, the structure of the jaws and the opercular bones reveal that more one species is found in this locality. The so-called “pholidophorids” fishes of La Cantera Formation are in revision in order to clarify their morphology and their systematic position.

MAASTRICHTIAN SHARKS OF THE ESCONDIDO FORMATION IN THE SABINAS BASIN, NORTHERN COAHUILA

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We report the finding of fossil shark teeth in the locality Rancho Los Robledo, locality number 7 of PASAC of the Escondido Formation, Maastricthian age, in the Sabinas Basin, Northern Coahuila (equivalent to the upper part of the Difunta Group that outcrops in the southern part of the State of Coahuila). The stratigraphic sequence consists of yellow and grey light color limestones and coquinoid-sandstones, alternating with gray dark color shales and siltstones, apparently without fossils. The shark teeth recovered in the limestones, require chemical and physical preparation to freed them of the rock. The recorded taxa consist of Carcharias sp., Anomotodon sp., Cretalamna appendiculata (Agassiz, 1843), Cretalamna maroccana Arambourg, 1935, Serratolamna serrata (Agassiz, 1843), Squalicorax kaupi (Agassiz, 1843), Ptychotrygon sp., and reptilian teeth without identification. Most of these cosmopolitan contemporaneous species have been recorded also in other localities in North America including the Difunta Group, Parras Basin, the Potrerillos Formation in Nuevo León, and in the Ocozocoautla Formation from Chiapas, Southern México.

PARTIAL SKELETON OF SQUALICORAX FALCATUS (LAMNIFORMES: ANACORACIDAE) FROM THE EAGLE FORD FORMATION (TURONIAN) IN THE LOS TEMPORALES QUARRY, NORTHWEST OF MUZQUIZ, COAHUILA, MÉXICO

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We report the recovery of a partial skeleton of the cow shark Squalicorax falcatus (Agassiz, 1843) from the Los Temporales quarry, Northwest of Múzquiz, Coahuila State, México. Several invertebrate specimens and teleosts have also been recovered from this quarry and nearby flagstones quarries located 120 to 150 km northwest of the city of Múzquiz. These outcrops belong to the Turonian Eagle Ford Formation.

The specimen MUZ 365 from the Museo de Muzquiz Collection corresponds to an early member of the Squalicorax falcatus lineage (Late Cenomanian-Santonian), and consists of a partial skeleton preserved in two slabs (part and counterpart), including partially the skull, and at least 60 disarticulated teeth, as well as the first 10 anterior vertebrae. This record expands the paleogeographic distribution of Squalicorax falcatus, which was previously known from the Carlile Shale of Kansas and other related marine sediments deposited in the Upper Cretaceous Interior Seaway of North America, from Canada to Northern Mexico, and the Western Tethys Sea.

LATE CRETACEOUS SHARKS FROM THE PEN FORMATION IN NORTHWESTERN COAHUILA, MEXICO

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The Pen Formation that outcrops in the northwest of Coahuila state consist in a sequence of limestones intercalated with calcareous sandstones and shales, that includes marine fossils. In the locality of San Miguel (Ocampo municipality) the following sharks have been recovered: Cretoxyrhina mantelli, Cretalamna apendiculata, Scapanorhynchus texanus, and Squalicorax kaupi. Mosasaur teeth referable to Halisaurus also have been found in association with the sharks. Biostratigraphic correlation with foraminifers such as Heterohelix sp. and bivalves like Exogyra ponderosa proves a Late Santonian/Early Campanian age. The shark assemblage corresponds to part of the Late Cretaceous Interior Seaway, correlated in part, with the Smoky Hill Chalk (Niobrara Chalk Formation) in Kansas and to the marine member of the Lower Aguja Formation that outcrops in the Big Bend of Texas, and other localities in the Gulf of Mexico.

A NEW MACROSEMIID (HALECOSTOMI) FROM THE ALBIAN TLAYÚA QUARRY, CENTRAL MÉXICO

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The family Macrosemiidae is represented by five different genera in México; four of them are from the Albian Tlayúa quarry, central México, and the other comes from the Albian El Espinal quarry in Chiapas State, southern México. Macrosemiids have been reported in Triassic to Cretaceous deposits of Europe and Africa, but the Mexican macrosemiids signify the first record for America and one of the youngest. Notagogus and Macrosemius are the only eastern Tethys genera reported in México. This new taxon is closely related to Notagogus, but it also exhibits a combination of apomorphic and plesiomorphic characters present in other members of the family. These characters include: long narrow body with a maximum standard length of 132 mm; dorsal fin divided; pectoral fin without fulcra; pelvic fin with fringing fulcra; infraorbitals scroll-like forming delicate scrolls around the upper and lower borders of the infraorbital sensory canal; supratemporal bone present; symplectic triangular not in contact with the preopercle, separating the quadrate and quadratojugal; maxilla bearing a narrow canal that branches in the posterior expansion of the bone, each branch ending in a small sensory pore; mandibular sensory canal enclosed in a bony tube in the anterior part of the dentary, but running in a groove in the posterior part of the bone; dentary teeth stout and reduced in number, increasing in size to the rear; squamation complete. This is the first time that the shape and position of the symplectic is observed in macrosemiids. A sensory canal running in the maxilla is also reported for the first time for a macrosemiid, a character that it is also present in halecomorphs.

A FOSSIL AGONID (ACTINOPTERYGII, TELEOSTEI, PERCOMORPHACEA) FROM THE ALBIAN-CENOMANIAN OF MÉXICO

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An advanced teleost in the Albian-Cenomanian of the Muhi Quarry near Zimapán, State of Hidalgo, México, has been discovered. The body of the new agonid, a scorpaeniform percomorph, is covered with three series of bony plates on the flanks. The dorsal series forms the border of a flat to depressed dorsal region, whereas the ventral series forms the ventral border of the body. The pectoral fin consists of seven short unbranched rays, and lies at the level of the middle series of bony plates. The pelvic fin, represented by the pelvic girdle, lies below the shoulder girdle. The anal fin is positioned close to the head at the level of the third bony shield behind the head. The posterior part of the body is not preserved.

The skull is preserved in lateral view. In front of the preoperculum, three broad infraorbitals (Io 2 to Io 4/5) are preserved. This is a primitive feature for agonids. Modern agonids lack a broad infraorbital 4/5; they have an infraorbital 4/5, which just surrounds the infraorbital canal. The rostral part of the skull is separated from the posterior part and body. The separated rostral part consists of the deep premaxilla and the nasal bone with the typical shape of agonids. Today agonids are cold water adapted forms occurring in northern and southern high latitudes. That was not the case in the Cretaceous. The Muhi quarry was at that time close to the equator. Therefore the agonids were not cold-water adapted 100 Ma ago.

Agonids are known from otoliths back to the upper Eocene. The occurrence of agonids in the Early-Late Cretaceous places the appearance of advanced teleosts into the Early-Late Cretaceous so that one has to postulate an accelerated evolution of teleosts between the Late Jurassic (with the first occurrences of modern basal teleosts) and the Early Cretaceous.

ADVANCES AND PROBLEMS OF STANDARDIZING MORPHOLOGICAL DATA

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The need to communicate among researchers around the world and share morphological data, images and information was spurred in recent times by the initiation of the National Science Foundation’s Advancing the Tree of Life (AToL) program. For the first time massive amounts of data needed to be archived for use by multiple participants, and a standardized way to input data into an achievable repository needed to be established. Developing a standardized language or ontology of morphological structures also became paramount and imperative for communication purposes. For example, a standardized identification and definition of the parasphenoid bone is essential to ensure that all researchers are communicating about the same element across taxa. With these advances in standardization however, came problems and limitations in generalizing morphological definitions. The so-called frontal bone can be defined simply as the paired element anterior to the parietal and/or supraoccipital bones in teleosts, but is this element as defined homologous in all fishes? Is ural centrum 1, if defined as the caudal element posterior to preural centrum 1 homologous among teleosts? Data from recent developmental studies suggest no. This presentation will address several advances in sharing and storing morphological data used among Tree of Life participants, and discuss various systems such as ZFin and Phenoscape used to construct a standardized ontology of teleost morphological structures. Limitations of these initiatives are addressed, as well as the need for incorporating a homology concept into ontologies.

PHYLOGENETIC RELATIONSHIPS OF BASAL EUCANTHOMORPH FISHES: A PRELIMINARY ASSESSMENT OF MORPHOLOGICAL AND MOLECULAR DATA

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The Eucanthomorpha consists of Polymixiacea (Order Polymixiiformes) plus what has been traditionally known as the Paracanthopterygii. Basal representatives of Paracanthopterygii have included the Percopsiformes, Gadiformes, and Lophiiformes. Recent molecular data suggest however, that Zeiformes form a sister group relationship with Gadiformes, and that Lophiiformes are more distantly related. For many years a considerable number of studies have examined subgroups within Eucanthomorpha (e.g., percopsiforms, gadiforms). Some studies have used molecular data exclusively, while others examined fossil and morphological characters. Often the molecular and morphological data have been incongruent. As part of the Euteleost Tree of Life (EToL) project funded by the National Science Foundation, a pivotal first step in understanding euteleost evolution is to better understand the relationships of basal eucanthomorphs. Presented here is a reassessment of all current research on basal eucanthomorphs with a special emphasis on fossil forms. Morphological characters from both fossil and extant taxa are reexamined, and in addition to new developmental characters, morphological cladograms are compared with those generated from molecular data. This study represents an important first step in integrating morphological and molecular characters resulting in a better understanding of eucanthomorph relationships.

THE PACHYRHIZODONTID FISHES OF THE MUHI QUARRY (ALBIAN-CENOMANIAN), HIDALGO, MÉXICO

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We have found two well preserved pachyrhizodontid heads in the Albian-Cenomanian Muhi quarry of Zimapán, Hidalgo State, central México. The specimens exhibit large frontal bones (traditional terminology), small parietal bones separated by the supraoccipital, pterotic with a well developed spine, very large dermosphenotic, small and tubular nasals, two large posterior infraorbitals broad, hyomandibula with simple articulatory head and with a well-developed lateral process adjacent to the opercular process, broad and elongated maxilla with numerous strong teeth, a single supramaxilla, dentary with a single row of teeth, and pectoral fin low in flank. Preliminary interpretation of the specimens indicates a close relationship to Rhacolepis and Pachyrhizodus, but the Muhi quarry specimens bear a combination of characters present in both genera.

Pachyrhizodontids had a worldwide distribution during Cretaceous times. There are four records of the group in México, but this is the first Albian-Cenomanian evidence in the country, which is also notable because of the presence of few juvenile complete specimens, which are under study.

SCIENTIFIC EXCAVATION VERSUS RANDOM COLLECTION IN A FOSSIL LAGERSTÄTTE – A CASE STUDY AT VALLECILLO, NE MEXICO

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The platy limestone at Vallecillo is famous for its richness in well preserved fossils. Fishes are often preserved with finest structures of their fins, intestinal contents and scales that may outline the former body shape. Skin preservation and intestinal contents are recorded from various fossil mosasauroids from that locality. During the last decade, many fossils were randomly collected by the quarrymen and scientists when walking the quarries, spoil heaps or stone yards. After collecting a considerable diversity of fossils, a layer by layer excavation of a defined area was carried out in order to retrieve a statistical data set with all fossils registered in their spatial and stratigraphic context.

Comparison of both collection types reveals a biased composition of the random collection, because the local workers collected selectively, with preference on large and beautiful looking specimens. The majority of specimens was collected without or only coarse stratigraphic data. However, the enormous surface surveyed by the local workers during their every day work provided a large number of well preserved specimens, useful for anatomical and taxonomical studies. This collection also includes rare taxa such as sharks and marine reptiles such as mosasauroids, a pliosaur tooth and chelonians.

The scientific excavations yielded data of statistical relevance and allowed the monitoring of the stratigraphic distribution of fossils and their relative abundance in the lithologic column. The data set mostly refers to taxa known to be abundant from the random surface survey, while rare taxa are unlikely to be unearthed due to limited material turnover. However, two scientific excavations yielded hitherto unknown tiny fishes, likely a new taxon. The primary fragments revealed an enormous abundance of the surface dwelling fish Rhynchodercetis, which is rare in the random surface collection. In addition, the excavated ammonites and inoceramids allow the precise biostratigraphic zonation of this latest Cenomanian to early Turonian fossil Lagerstätte, with one of the most complete stratigrapic records worldwide.

For the interpretation of a fossiliferous area both types of collections are important: the random surface survey yields mostly well preserved and diverse taxa, whereas the scientific excavation provides statistical and stratigraphical data, allows conclusions on the taphonomy of primary fragments and in cases yield new but unspectacular taxa, overseen in the random surface survey.

DATABASES AS KEY TO UNDERSTANDING FOSSIL LAGERSTÄTTEN – AN EXAMPLE FOR VALLECILLO, NORTHEASTERN MEXICO

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The main functions of databases are to organize large quantities of data, and to save them efficiently, permanently and unambiguously. In paleontology, the link between an individual fossil and the related dataset can be achieved by field or collection numbers. This kind of information storage was applied to fossil from Vallecillo, north-eastern Mexico, from a very early stage of research and still continues. All fossils excavated from this Lagerstätte are registered in databases, and over the years, the quantity of their data has reached statistical significance.

At Vallecillo, two strategies of collecting exist, the random survey and layer-by-layer excavation, described separately in this volume. The databases are organized in two styles to accommodate the different datasets. 2100 findings from five field seasons are currently registered in the excavation database. The advantage of this collecting type is the absence of a bias; the data are absolute. The databases of the random surface survey include the specimens registered at the Facultad de Ciencias de la Tierra, Universidad Autónoma de Nuevo León in Linares and the Museo del Desierto in Saltillo. At the moment it comprises ca. 600 specimens. This collection is strongly biased but provides abundant biometrical data.

So far, the data collected at Vallecillo provide insight into intraspecific aspects such as ontogeny, stages of decay, and frequency changes. Traced over the section, this may allow us to discover evolutionary changes within one taxon. Interspecific studies included correlation of the before mentioned interpretations for different taxa to identify parallel evolution. Such interspecific correlations may allow for conclusions on interspecific interactions or similarities in paleoecology not visible at first glance. A further step may include the interpretation of data from different Lagerstätten. Databases are an attractive tool for the interpretation of the huge datasets related to a large quantity of fossils, because they allow for fast filtering of data, and for combination of data from different databases. This combination will provide further insight into the petrified ecosystem preserved at Vallecillo.

RESEARCH INTO THE TURONIAN (LATE CRETACEOUS) FOSSILS FROM THE PLATY LIMESTONE AT VALLECILLO, NUEVO LEÓN, MEXICO – STATE OF THE ART

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The Vallecillo platy limestone is interpreted as an outer shelf deposit suggesting water depths of more than 100 m, and a distance of at least 500 km from the nearest shore. The water column was layered, with dysoxic to anoxic hostile bottom conditions. The surface waters, however, yielded supreme conditions for abundant marine life. The dys- to anoxic bottom conditions are related to the Late Cenomanian Oceanic Anoxic Event 2, which in the Vallecillo sea apparently persisted into the Early Turonian and caused the environmental conditions for excellent fossil preservation.

Vallecillo is famous for its abundant, well-preserved vertebrates, among them abundant fishes, but also early mosasauroids, turtles and a pliosaur tooth. The continuous fossil record allows for biostratigraphic subdivision by ammonites, inoceramid bivalves and planktonic foraminifers, with the one of the most complete early Turonian records worldwide.

Fishes are abundant and diverse in the Vallecillo fossil assemblage. To date, at least 14 taxa of selachians, chondrosteans and teleosteans were identified. They are introduced in the field guide in this volume. The abundance of fossils allows the taphonomic interpretation of the three most abundant Vallecillo fishes: Rhynchodercetis, Tselfatia and Nursallia differ in preferred water depth, feeding strategy and locomotion. They constitute the majority of the fossil vertebrate assemblage at Vallecillo, but they existed in the Vallecillo sea without interfering each other. However, more results regarding the ontogeny, paleobiology and paleoecology of the fossil vertebrates and invertebrates from Vallecillo are under work.

Today, the Vallecillo Platy Limestone and its fossil assemblage represent one of the best understood fossil Lagerstätten in México, even though paleontological research has just started.

ICHTHYODECTIFORM FISHES FROM THE UPPER CRETACEOUS (CAMPANIAN) OF ARKANSAS, U.S.A.

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Ichthyodectiform fishes have been documented from Upper Cretaceous deposits of the Atlantic and Gulf Coastal Plains and Western Interior Seaway of North America. However, reports are lacking from the Mississippi Embayment of the western Gulf Coastal Plain. We present descriptions of historic and recently collected ichthyodectiform fish material from Campanian deposits of southwestern Arkansas, U.S.A. A partial skull of the saurodontid Saurocephalus lanciformis from the middle Campanian Ozan Formation represents the first record from Arkansas and affords description of the previously undescribed ectopterygoid teeth. Historic and recently collected specimens of the large ichthyodectid Xiphactinus audax are reported from the lower Campanian Brownstown Marl Formation. Based on skull and vertebral material, these specimens confirm the presence of X. audax in the lower Campanian of the western Gulf Coastal Plain and not the congeneric X. vetus. The number of individuals represented by these specimens suggests that conditions along the western margin of the Mississippi Embayment appear to have been favorable for supporting a robust population of adult Xiphactinus. These records of ichthyodectiform fishes: (1) help fill the hiatus, between reports from the Mississippi Embayment of the eastern Gulf Coastal Plain with those from the Western Interior Seaway, in the geographic distribution of these taxa; and (2) represent additions to our knowledge of the geologic occurrence of these species.

LUNGFISH AS ENVIRONMENTAL INDICATORS

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Fossil deposits in Australia include many lungfish preserved as tooth plates, extending from the Cretaceous to the Pleistocene. The fossil species had a dentition, and jaw architecture, similar to those of the living N. forsteri, and the ways in which the dentition was used are equivalent. Pathologies and wear conditions on the tooth plates of both fossil and living lungfish are comparable.

Lungfish live for a long time, and, unlike many other fish, do not replace their tooth plates. Consequently dental decay is a common pathology among tooth plates from older animals. This condition may develop as a result of mechanical damage from harsh items in the diet, trapping of damaging items between the teeth and the gums, or exposure to stagnant water containing infective organisms. A high incidence of dental decay, and other pathologies such as abscesses or parasitic invasion of dental tissue in material from a locality indicates a poor environment.

Harsh food produces heavily abraded tooth plates, as well as a greater proportion of fish using crushing jaw movements. Soft food, and a grinding action of the jaws, results in smoother wear of the occlusal surface. Another form of dental wear, called attrition, occurs when teeth are ground together without food being present. A high proportion of tooth plates in a population that show attrition indicates that food is not plentiful, or that fish did not feed for reasons related to stress, such as disease, crowding, or competition for suitable refuges.

Three Mesozoic deposits in Australia that include significant numbers of fossil lungfish tooth plates have been examined for dental wear and pathologies. Cretaceous deposits at Griman Creek (Lightning Ridge, New South Wales) include many tooth plates preserved as natural casts, some opalised. Most belong to Metaceratodus wollastoni. These tooth plates show little evidence of disease, and wear is smooth. This suggests that they ate soft food, and that the environment in which they lived was clean. Fossils of a similar age from Dinosaur Cove in Victoria include several species of lungfish, M. wollastoni among them, and are heavily worn although they show little disease. This indicates a harsh environment and rough food. Fossils from Cretaceous deposits in Longreach (Queensland), including M. wollastoni and the related Metaceratodus ellioti, are mostly poorly preserved and many were exposed on the surface. The few that were not exposed are not heavily worn, nor diseased, so the environment may have been easy with plentiful food. The condition of tooth plates from the Mesozoic deposits contrasts sharply with that of tooth plates from Cainozoic localities, where diseased material is common and wear usually extreme. The dentition of living lungfish, collected recently from lakes and rivers, is worse than those in any fossil deposit, suggesting that living lungfish and their environments are in trouble.

TO BE OR NOT TO BE A MESOZOIC STOMIIFORM. THREE CANDIDATES FROM JBEL TSELFAT (CENOMANIAN-TURONIAN, MOROCCO)

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The Stomiiformes are Euteleostei occurring in meso and bathypelagic environments. As their bones are very thin and their main synapomorphies are based on non osteological characters (e.g., the structure of photophores), their fossil record is poorly known. Some Eocene taxa clearly belong to this clade, but only putative representatives have been found in Cretaceous levels.

The Cenomanian-Turonian deposit of Jbel Tselfat, Morocco, is reconstructed as a deep marine environment. Three species from this locality (Paravinciguerria, Protostomias, and Idrissia) have been attributed to Stomiiformes during the last decades but the validity of these assignments remains questioned. Thus, re-descriptions of these taxa and comments on their phylogenetic relationships are proposed here.

Paravinciguerria praecursor is a small and elongated fish. Its initial assignment among Stomiidae was based on its high similarity with the extant genera Gonostoma and Vinciguerria. The structure of the hyoid arch is not clearly visible in the fossil material but the last enlarged branchiostegal ray evokes the hypertrophied one of Stomiiformes. Other characters such as the very elongated and curved toothed maxilla, the lightened skull and the morphology of the suspensorium confirm its inclusion into Stomiiformes.

Protostomias maroccanus and the close relative Pronotacanthus sahel-almae from the Santonian of Lebanon, are eel-like teleosteans. The structure of the caudal skeleton and the skull, and the trajectory of the sensory canal do not support their position among Stomiiformes. They show numerous skull analogies with the genus Spaniodon (Santonian, Lebanon), as a dentary with a high coronoid process and two well developed caniniform teeth, the trajectory of the infraorbital sensory canal, and the proportions of the branchiostegal rays. However, some marked differences, as the vertebral count (80 vertebrae in Protostomias and "only" 58 in Spaniodon), the position of the dorsal fin, the premaxilla (apparently toothless in Protostomias) do not support a close relationship among these genera.

The case of Idrissia jubae is more complex. From the six specimens used in the first description of this species, only two belong to the species; another is referred to Rharbichthys ferox; and the others belong to an indeterminate taxon. The diagnostic characters are re-studied but the poorly preserved material does not permit to clarify the taxonomic assignment of Idrissia jubae, which remains unclear among Euteleostei. The Cenozoic species Idrissia turkmenica, I. carpathic, and I. carpiromanica must be also re-studied to confirm their inclusion within the genus.

In conclusion, only Paravinciguerria represents a stomiiform. Protostomias and Idrissia are regarded as Euteleostei incertae sedis. This study confirms the presence of the Stomiiformes clade in Late Cretaceous.

THE FIRST ?ICHTHYODECTIFORM FROM SCOTLAND

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The disarticulated skull of a large predatory bony fish represents the first osteichthyan component of an otherwise exclusively reptilian (particularly ichthyopterygian) marine fauna from the Upper Kimmeridgian Boulder Bed of Lothbeg Point (58.06278°N, 3.76673°W), south west of Helmsdale, Sutherland, on the north east coast of Scotland. Acid-prepared from a large nodule, the skull was originally identified as an aspidorhynchiform by Patterson. Subsequently, the remaining unprepared nodule was scanned using computerised tomography, to reveal the extent of remaining bony elements within the matrix, and determine whether further preparation was necessary. Although lacking the rear elements of the skull, an extensive set of mandibular, maxillary and palatal elements are present, and can be used as the basis of a tentative diagnosis of ichthyodectiform.

GILL RAKER CHARACTERISTICS AND THEIR VALIDITY AS A TAXONOMIC TOOL: PROBLEMS WITHIN THE PACHYCORMIFORMES

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Currently, pachycormiforms are interpreted by some authors as possible stem-group teleosts, and they are therefore important in understanding the phylogeny of advanced actinopterygians. However, the morphology of pachycormiforms is poorly known, a fact that makes any phylogenetic study involving pachycormiforms difficult.

The main goal of this contribution is the study of branchial arches elements in pachycormiforms. Gill rakers (or fanunculi) are elements of the gill skeleton (branchial basket) in fish, that function primarily to protect respiratory lamellae, and sometimes have a secondary role in feeding. Characteristics of gill rakers have been used for taxonomic diagnosis and cladistic analysis of the interrelationships of Pachycormiformes, with particular importance for Leedsichthys and Asthenocormus. The material on which these determinations have been based is reviewed, along with the validity of use of gill rakers in analysis of extinct fish in general, based on their utility in extant fish. Gill rakers are demonstrated to be an unreliable source of taxonomic characters. The assignation of specimen PETMG F34 to Leedsichthys is questionable, but its dissimilarity to recognised specimens of Leedsichthys may be due to its subadult nature. The validity of Leedsichthys notocetes as a distinct species from Leedsichthys problematicus is called into question, as the primary distinction between the two appears based on an artefact structure generated by erosion and fracture.

AN ERA OF SUSPENSE: THE ECOLOGICAL EVIDENCE AND MESOZOIC RECORD OF A LINEAGE OF LARGE OSTEICHTHYAN SUSPENSION FEEDERS

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The current ecological niche of large (> 1 metre Standard Length) suspension-feeding marine vertebrate is today dominated by mammals and chondrichthyans. However, fossil evidence suggests that this functional role was dominated by actinopterygians during the Mesozoic era. Prior to the Mesozoic, the largest unequivocal example of an aquatic vertebrate suspension-feeder (as an adult, so excluding juvenile stages of suspension-feeding) was the Carboniferous-Permian acanthodian Acanthodes (SL=40-50cm). The best known candidate for a large marine suspension feeder in the Mesozoic is the pachycormid Leedsichthys. This genus reached remarkable sizes (SL = 8.9 m) and appears to have been broadly distributed geographically, with remains reported from England, France, Germany and Chile. Apart from Leedsichthys, candidate suspension feeders in the Mesozoic have been limited to putative Cretaceous megachasmid teeth and some Triassic ichthyosaurs, but anatomical evidence for functional interpretations is scant in both cases. In contrast, arguments that Leedsichthys was a suspension feeder derive from multiple aspects of its anatomy: fin arrangement, long, closely-spaced gill rakers, absence of marginal dentition on the oral jaws, a broad gape, and exceptional size. This wide-ranging genus has been recovered from England, France, Germany and Chile. Some have argued that Jurassic trace fossils from Switzerland were made by this fish, and point to iliophagy (i.e. detritus-feeding or sediment sieving) as a not uncommon secondary strategy for suspension-feeders. Several close relatives of Leedsichthys are known, and these might have occupied similar functional roles. Among these is the Jurassic (Kimmeridgian) Asthenocormus, but outstanding questions about the morphology—and, by extension, ecology—of this fish persist despite the collection of several articulated specimens from the lithographic limestones of Solnhofen. More recent work reveals a second probable suspension-feeding pachycormid in the Callovian of England (Martillichthys renwickae) plus additional candidates ranging from the Lower Jurassic (Toarcian) to the Lower Cretaceous (Albian). Thus it appears that far from being a lone actinopterygian experiment in suspension-feeding at large body sizes, Leedsichthys was in fact the just one member of a diverse clade of pachycormids occupying this trophic role.

A NEW OPHIOPSID FROM TLAYÚA QUARRY (LOWER CRETACEOUS, ALBIAN), PUEBLA, CENTRAL MÉXICO

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Ophiopsidae is a family of halecomorph fishes considered, together with the family Ionoscopidae, as forming the Ionoscopiformes (sensu Grande & Bemis 1998). Ophiopsids are known by four genera and 13 nominal species. The family Ophiopsidae has a temporal range from the Triassic to the Early Cretaceous and is distributed throughout Europe, Africa, North America, and South America. In Mexico, ophiopsids are known since 1988 when Teoichthys kallistos was described by Applegate from the Lower Cretaceous, Albian lithographic limestones of Tlayúa quarry at Tepexi de Rodríguez, State of Puebla. Recently, new specimens of ophiopsids from this locality were discovered. This new material differs from Teoichthys kallistos by the ornamentation of scales, size and position of the dorsal fin, and body proportions, resembling more the European ophiopsids. The description of a new taxon will be presented.

A NEW PYCNODONTID SPECIES FROM THE LOWER CRETACEOUS OF THE TLAYÚA QUARRY, CENTRAL MEXICO

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The Tlayúa Quarry is well known for its beautiful preserved fossils, especially fishes. In this Early Cretaceous (Albian) locality there is a diverse and rich record of Pycnodontiformes. These fishes correspond roughly to one tenth of all fishes collected in the Tlayúa, however until now only one pycnodont species – Tepexichthys aranguthyorum Applegate, 1992 – was formally described. The "Colección Nacional de Paleontología" in the "Universidad Nacional Autónoma de México" houses at least five new pycnodontid species from the Tlayúa Quarry remaining to be described. One of those species, known only by three specimens, can be clearly differentiated from the others by the presence of a dorsal prominence, a character only present among pycnodontids in the species Stenamara mia Poyato-Ariza & Wenz, 2000. However, the Mexican species has a very distinct morphology. The new species can be clearly placed within the family Pycnodontidae because it exhibits a penicular process in the parietal, which represents the single autapomorphic character of this family. Other than the presence of a high and pointed dorsal prominence, the new species can be distinguished from other pycnodontids by a singular combination of characters, such as the head length corresponding to approximately half of the standard length, presence of a dermocranial fenestra, greatly expanded lateral laminae of the mesethmoid, only two rows of teeth on the prearticular, elongated teeth on the main prearticular row, neural and hemal corresponding arcocentra not surrounding the notochord, and 1-3 large spines on the contour scales.

A REDESCRIPTION OF PYCNODUS LAVEIRENSIS (PYCNODONTIFORMES, PYCNODONTIDAE) FROM THE CENOMANIAN OF LAVEIRAS, PORTUGAL

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The pycnodontid species Pycnodus laveirensis de Veiga Ferreira, 1961, from the Laveiras quarry found in the Cenomanian of Portugal, was briefly described on an article reviewing the Cretaceous ichthyofauna of Portugal. Due to the lack of a more detailed description and by the fact that this species is known from juvenile-like specimens, P. laveirensis was considered later as a nomen dubium. The recent discover of new and still undescribed species of the genus Pycnodus in México increases the necessity of a redescription of P. laveirensis. Observations based on seven specimens, belonging to the Museu Décio Thadeu (Lisbon, Portugal) and the Universidade do Estado do Rio de Janeiro (Brazil), show that Pycnodus laveirensis is a valid species; and can be placed in the genus Pycnodus by the combination of various characters, including the presence of a dermocranial fenestra, the skull roof posteriorly recessed with the posterior part of endocranium exposed, and scutellum-like contour scales present only in the dorsal border. Pycnodus laveirensis is promptly distinguished from P. apodus – the type species, and currently the only recognized species of the genus known from articulated material – by the number of neural and hemal precaudal vertebral elements, by the size of dorsal and anal fins in relation to the standard length, and consequently the point of insertion of both impaired fins, and by the presence of two post-cloacal scales (instead of one, as in P. apodus), among other characters.

AN ACTUOTAPHONOMICAL APPROACH TO FACTORS OF FISH PRESERVATION IN KONSERVAT- LAGERSTÄTTEN

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Fish taphonomy is a rare field of study where factors and processes are often taken for granted. However, the experimental approach to the preservational features of the fossil entities from any site is a fundamental tool in order to develop a palaeoecological restoration of the environment at the moment when the fossils-to-be were produced, and also when trying to understand the events that occurred later on, during the fossilization process. The actuotaphonomic approach generates models that allow comparisons between the features of carcasses of recent forms and similar fossil remains by measuring and controlling environmental variables during the processes of alteration of the remains. We have initially applied this methodology to the study of the preservational features of the fishes from Las Hoyas.

With this objective, a series of small (i.e., qualitative rather than quantitative) actuotaphonomic experiments has been carried out by using carcasses of teleostean fishes of different sizes in different controlled environments. They were used in two series of experiments.

The first series was an exhaustive monitoring of the biostratinomic decomposition processes of three groups of carcases in different static environments with controlled conditions, focusing not only on the changes suffered by the bodies but also on those which happened to the environment itself. In these experiments, factors like the temperature, the absence of currents, or the absence of scavengers have been controlled. Thus, it has been possible to observe the influence of other environmental factors (e.g., water salinity), as well as anatomical factors (e.g., size) during the decomposition processes.

The second series consisted of a study of the biostratinomic alterations due to mechanical disturbances without allowing time for decomposition. This allowed observation of the effects of abrasion processes alone.

The results are focused on an analysis of the carcasses curvature and on trying to identify the factors involved in the disconnection, disarticulation, and dispersion patterns of the different series of fishes. In these experiments, the aim was to make a preliminary comparison with the small teleosteans from Las Hoyas. Bearing this in mind, one of the controlled environments of the experiments was prepared trying to reproduce the features of this fossil site, so the comparison would be as reliable as possible. However, the preliminary results may allow comparison with the preservational features of small fossil teleostean fishes recorded at any given fossil site.

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AMIIDAE FROM THE LOWER CRETACEOUS OF SPAIN AND THEIR BEARING ON SOME TAXONOMIC ISSUES

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Amiiforms have been known from the outcrop of La Pedrera, from the region of El Montsec, Catalonia, for over a century now. They were initially assessed to the genus Megalurus, and subsequently transferred to Urocles. The second amiid from El Montsec was, at the time, an endemic genus, Vidalamia.

Urocles is a typically Mesozoic genus whose taxonomic history dates back to 1833, when Agassiz, based on manuscripts of Münster, describes for the first time, along with four species, the genus Megalurus from the laminated limestones of Solnhofen (Germany). Its name would later be changed due to synonymy problems, and later again to Urocles by Jordan in 1919.

Throughout the XIX and XX centuries, up to sixteen different species, mostly coming from the Upper Jurassic-Lower Cretaceous of Occidental Europe (Solnhofen, Cerin, Bincombe and Swanage, El Montsec), were described within this genus. Lange, who carried out a review of the genus after studying several new specimens in 1968, held the existence of eleven different species. In the same year, Wenz suggested that the specimens of Urocles from El Montsec (based on additional material from a second, younger outcrop called La Cabrùa) could be considered rather as Amiopsis. Wenz confirmed this later in 1988 and 1995. Additionally, one species initially assessed to Urocles (Megalurus) was transferred to Vidalamia.

Subsequently, in 1998, Grande and Bemis, in their extensive study about the family Amiidae, invalidated the usage of the genus Urocles, considering it a junior synonym of the genus Amiopsis described by Kner in 1863. As a consequence of their usage of the cladistic methodology and their study of whole ontogenetic series of the extant species Amia calva, which allowed them to establish inter- and intra-specific ranges of variance, as well as the examination of new material and the utilization of more modern preparation techniques, they could determine the majority of the species of this genus to be synonyms. They redefined these species within other genera of the family Amiidae, basically Amiopsis and Solnhofenamia, and established Vidalamia as the type genus of a new subfamily within the Amiidae.

When the locality of Las Hoyas (Cuenca) was discovered, the amiid specimens unearthed were initially related to the genera and species from El Montsec. Current work will eventually confirm this assessment or reveal whether the forms from Las Hoyas are different taxa.

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ANATOMICAL REVIEW OF †SALMINOPS IBERICUS GAYET, 1985 (OSTARIOPHYSI, SALMINOPSIDAE) FROM THE CENOMANIAN OF CARANGUEJEIRA FORMATION, LEIRIA, PORTUGAL

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†Salminops ibericus is a Cenomanian (Late Cretaceous) fish recovered from the marine deposits of Caranguejeira Formation, Leiria province, Central Portugal. In the original description this fossil fish was related to the otophysan clade Characiphysi based on five synapomorphies. These are: 1) vomer articulating posteriorly to the mesethmoid; 2) absence of the second supraneural; 3) neural spine of the third centrum laterally positioned to the supraneural; 4) foreshortening of the first four centra; and 5) absence of parapophysis on the first centrum. Our re-examination of the fossil material reveals that the original description was based on badly preserved specimens and we suspect a possible over-interpretation of certain bony structures especially in the ethmovomerian region, suspensorium and anterior vertebral areas as well as in the caudal skeleton. Consequently, we have re-investigated the anatomy of †Salminops ibericus and re-evaluated its systematic position. Our results show that most of the characters related to the first five centra previously described as belonging to a primitive otophysan Weberian apparatus could not be observed and that the vertebrae do not have any special modifications related to such structure. In the caudal skeleton, we count eight hypurals, possibly nine, but not six. Characters related to the vomer and to the supraneural complex cannot be evaluated because the structures are not preserved. The only observed character related to Characiformes is the presence of maxillary teeth, though in †Salminops it cannot be determined if it is a multicuspid teeth as it is in the order. Based on this review we reject the inclusion of †Salminops ibericus within Characiformes and within Ostariophysan. We consider this species a teleost incertae sedis.

A MULTIVARIATE APPROACH ON THE ELLIMMICHTHYIFORMS OF TLAYÚA QUARRY (LOWER CRETACEOUS), TEPEXI DE RODRÍGUEZ, PUEBLA, MÉXICO

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Approximately 3.3% of the macrofossils recovered from the Tlayúa Quarry (Lower Cretaceous), Tepexi de Rodríguez, Puebla, México, and deposited in the Colección Nacional de Paleontología, Instituto de Geología, UNAM are represented by members of the Order Ellimmichthyiformes. In 1997, all ellimmichthyiforms of Tlayúa were assigned to the genus Ellimmichthys. However, and due to lack of preparation, cleaning and curation of these specimens, no thorough analysis on the material had been achievable until the present. After proper preparation, twenty-eight ellimmichthyiforms of Tlayúa were analyzed by using two multivariate techniques: Principal Component Analysis and Principal Coordinate Analysis. The results obtained from these techniques indicate the presence of at least two different groups in the sample. After a further revision of some qualitative characters, we tentatively assign one of the groups to the genus Armigatus. The analysis of the second group still requires more information to be conclusive.

REVISITING THE MORPHOLOGY OF THE ACTINOPTERYGIAN PREOPERCULUM

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The preoperculum has been considered a particularly important bone in the evolution of actinopterygians. It has been proposed that different configurations of preopercular bones are present in primitive Paleozoic palaeoniscoids, more advanced subholosteans, and holosteans. These differences have been attributed to changes in the jaw suspensorium and in turn, feeding mechanisms of these fishes. In order to revisit these hypotheses, the preopercular bones of various fishes have been examined. Generally speaking, the actinopterygian preoperculum is anterior to the operculum, posterior to the orbit, and bears the preopercular canal. Beyond these similarities, the preopercular bone is characterized by a staggering diversity of shapes, inclinations, number of individual elements, and associations with other bones. This diversity will be presented for a subset of Paleozoic, Mesozoic, and Recent fishes. The hypotheses regarding the evolution of the actinopterygian preoperculum will be critiqued. A significant hurdle to this study—the absence of a strong phylogenetic hypothesis of relationship for Paleozoic, Mesozoic, and Recent fishes, will be discussed.

GROWTH CESSATION MARKS IN BOWFINS — A TOOL FOR BIOLOGICAL AND PALEOECOLOGICAL RECONSTRUCTIONS

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Fossil fishes provide us with a broad range of tools for biological and paleoecological reconstructions. Growth cessation marks (GCM) in hard-tissue structures are frequently used for age and growth studies in various extant fish species. The same type of information can be derived from fossil species as well. Bowfins (Amiiformes) are known from a large variety of Mesozoic and Tertiary fossil sites. They are often represented by completely articulated individuals, but are also often known from disarticulated remains, e.g., isolated scales and/or vertebrae. Scales and gular plates were used for growth investigations in extant Amia calva published in 1967. We focus on scales and vertebra herein as otoliths are rarely preserved and other hard elements are often obscured. Both were investigated with respect to a reliable identification of GCM in extant A. calva and in a sample of the fossil amiid species Cyclurus kehreri from the middle Eocene World Heritage fossil site Messel Pit in Germany. Scales as dermal ossifications are more frequently influenced by external conditions compared to internal elements like the vertebral centra. In our sample 52.6% of almost 3000 investigated scales (n = 7 fish) of A. calva were regenerated. In the fossils, 79.4% of 5550 scales (n = 25 fish) were regenerated. Such scales do not show the full pattern of GCM and, therefore, are of restricted use in growth analyses. Vertebral centra do not undergo such modifications. They always mirror the complete life history of the respective individual and, therefore, are better suited for such investigations. Based on centra, we found the oldest individuals from Messel lived to be 11 years old, which is very similar in longevity to those from Cretaceous localities examined in NA. As expected from survivorship, the Messel population of C. kehreri was dominated by juveniles as small centra are common. However, a few large individuals were present and are known from rare isolated scales (2.48cm width) suggesting a TL of > 90cm; extant A. calva can exceed 100cm TL. Growth cessation marks are remarkably clear in most centra of C. kehreri compared to those of Cretaceous and extant centra at cooler latitudes. The clear GCM of C. kehreri suggest a seasonal influence on growth biology. Since the paleolatitude of the locality was only 38°N, the effects of seasonal photoperiod and temperature are assumed to play a relatively minor role in formation of GCM. Seasonal nutrient input associated with rainfall and dry seasons, maybe a more parsimonious explanation for the remarkably strong GCM.

NEW PARACLUPEID FISHES (TELEOSTEI: CLUPEOMORPHA: ELLIMMICHTHYIFORMES) FROM THE UPPER CRETACEOUS OF MOROCCO

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A collection of fossil fishes from a recently discovered locality in the Akrabou Formation at the edge of the Kem Kem Plateau in southeastern Morocco has yielded a number of new species, including the already described macrosemiid Agoultichthys chattertoni and at least two members of the Ellimmichthyiformes. One of the new ellimmichthyiforms is represented by numerous well-preserved specimens, and represents a new genus and species. The new species is included in a phylogenetic analysis of the order, and the results indicate it belongs to the family Paraclupeidae, rather than to its sister group, the Sorbinichthyidae. The second ellimmichthyiform was earlier represented by only a single poorly preserved specimen; however, collecting efforts at the locality in 2009 have provided two more specimens that are better preserved. This second species appears to be congeneric with the first, and is named as a second new species in the same new genus.

The order Ellimmichthyiformes ranges in age from Lower Cretaceous through Eocene, with the new Moroccan material being possibly late Cenomanian but more probably early Turonian. The Ellimmichthyiformes include species that have been found in a diversity of freshwater as well as estuarine, marginal marine, and fully marine habitats, from South, Central, and North America, the Mediterranean area, and China. Both the Sorbinichthyidae and the Paraclupeidae include both marine and freshwater forms. The two new Moroccan species of Paraclupeidae described here lived in marine waters of normal salinity, while the closest relatives of the two new species are from North America (Cenomanian, near-shore marine deposits) and China (Lower Cretaceous, freshwater deposits), confirming the near-cosmopolitan distribution and varied habitats of closely related forms during Lower to mid-Cretaceous time.

ACTINOPTERYGIANS FROM THE LOWER TRIASSIC UPPER BEAUFORT GROUP (SOUTH AFRICA) DOCUMENT MARINE INFLUENCE IN THE KAROO BASIN DURING EARLY TRIASSIC

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The Karoo Basin yields the most complete continental fossil record between the Carboniferous and the Jurassic. Within the Permian-Triassic sections of the Beaufort Group, fishes are found in six out of eight currently established Assemblage Zones (AZ). The well-known late Early /early Middle Triassic fish assemblage from the Bekkerskraal locality shares only the genus Elonichthys with Permian assemblages. All other known Triassic South African actinopterygians are neopterygians showing skull and fin features indicative of a markedly higher evolutionary level, and at least two genera, Saurichthys and Meidiichthys, are of marine origin. The lowermost Upper Beaufort Group (Lystrosaurus Assemblage Zone and the younger Cynognathus 'subzone A') has recently yielded remains of Saurichthys sp., Dicellopygae sp., Meidiichthys browni and up to three other basal actinopterygian genera. These actinopterygians show clear affinities with the Bekkerskraal assemblage. Meidiichthys browni (the most common species at Bekkerskraal) from Kliplaasdrift (lowermost Triassic Lystrosaurus AZ), is found completely preserved and associated with smaller, yet unidentified actinopterygians, whereas the overlying (younger) Cynognathus 'subzone A' yields more numerous yet more fragmentarily preserved remains. However, both assemblage biozones show clear affinities with the well-explored Bekkerskraal site (in the Cynognathus 'subzone B'), from where numerous well-preserved species have been described. In conclusion, the lowermost Triassic Karoo documents rapid invasion of advanced actinopterygians possibly linked to marine transgression in this part of Gondwana in the Early Triassic.

SERROLEPIS, A LITTLE KNOWN POLZBERGIID ACTINOPTERYGIAN FROM THE LOWER KEUPER (MIDDLE TRIASSIC) OF BADEN-WÜRTTEMBERG (GERMANY)

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Relatively complete remains, articulated specimens and isolated scales of Serrolepis suevicus, found in particular in horizons late Ladinian in age in the vicinity of Stuttgart and Schwäbisch Hall (Baden-Württemberg, southwestern Germany) allow reconstruction of this peculiar Middle Triassic actinopterygian, previously almost exclusively known by scales. S. suevicus is common in certain horizons of the upper Lower Keuper (Erfurt Formation, Middle Triassic), and occurs abundantly in the Albertibank. The skull is characterized by short and powerful jaws with a well-developed dentition including bi- or multicusped teeth. The preopercle is broad and crescent-shaped in outline. Infraorbitals are well-ossified and broad. Autapomorphic features of the skull include the large, laterally widened extrascapular and the posterior serration of the preopercle. Three lateral scale rows are deepened. All scales show a rich but variable ganoin ornament. The dorsal ridge scales in front of the dorsal fin project long, spiny processes. The caudal fin has at least five epaxial rays. Serrolepis is a polzbergiid actinopterygian revealing close affinities with Dipteronotus, Felberia and Polzbergia in the absence of a separate postrostral ossification and in the shape of the maxilla, preopercle and supracleithrum. Furthermore, the cheek and the caudal fin hint at more distant affinities with the Perleididae.

A NEW GENUS OF PERCOPSIFORMES FROM THE UPPER CRETACEOUS SCOLLARD FORMATION OF ALBERTA, CANADA

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A new genus and species of acanthomorph fish is described from the Maastrichtian Scollard Formation of Alberta. A single fish was recovered from a siltstone interbedded among alternating sandstone/siltstone deposits one meter above the Knee Hills Tuff, which is dated at 67 Ma. The nearly complete, mostly articulated specimen represents a five year old, adult (i.e., 80% of maximum size attained by age 2) and is about 45 mm total length. The specimen is classified as a paracanthopterygian because it has a full neural spine on preural centrum 2 and two epurals in the caudal skeleton. The fossil has an affinity with Percopsiformes as it has six branchiostegals and an opercle with an anterodorsal excavated margin. The specimen has characteristics of three families: Percopsidae, Aphredoderidae, and Sphenocephalidae. The fossil shares a very low dorsal process on the maxilla as seen in percopsids. However, the specimen has ornament on the lacrymal as seen in Aphredoderidae and Sphenocephalus, although the ornament on the Alberta specimen consists of fine serrae unlike the long serrae of Trichophanes or the coarse serrae of Sphenocephalus. There is a large, broadly expanded postmaxillary process of the premaxilla unlike that of other acanthomorphs. The premaxilla is not segmented as in Trichophanes or amblyopsids. Fine serrae also occur on the supraorbital margin of the frontal and the posterior margin of the posttemporal similar to the condition in Sphenocephalus, which has more posteriorly placed serrae on both elements. Fine serrae also occur on the broadly expanded, lower posterior apron of the cleithrum. Parapophyses are absent from vertebral centra 4 through 7 as in Mcconichthys; the first three centra are incompletely visible. The dorsal fin is short, with four spines and seven rays; the anal fin has four spines and six rays. The caudal skeleton has six hypurals and the parhypural is free from the centrum and the first hypural plate. The Alberta specimen differs from other paracanthopterygians in having a serrated cleithrum and broadly expanded postmaxillary process. The new fish adds significantly to the known diversity of the Paracanthopterygii. Like earlier members such as the Cenomanian marine Xenyllion, the European Campanian Sphenocephalus, and the Paleocene freshwater Mcconichthys, the new fish does not fit within extant families but rather helps document a Cretaceous–Paleocene radiation of percopsiforms from which the Eocene to Recent families evolved.

CLUPEOMORPHS FROM THE EL DOCTOR FORMATION (CRETACEOUS: ALBIAN-CENOMANIAN), ZIMAPÁN, HIDALGO STATE, MÉXICO

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The Muhi Quarry of Albian-Cenomanian age has produced diverse fish fauna which includes two different clupeomorph taxa. One of the specimens, even though is incomplete, can be assigned to the subfamily Clupeinae. This fish has a laterally compressed narrow body reaching a maximum height of 31 mm; the head is relatively long and narrow similar to other clupeids as Lile. The width of the head is proportional to the height of the body, the preorbital length is 14 mm and the postorbital length is 20 mm. The dorsal fin is positioned nearby the midpoint of the body as in Clupea. The first two dorsal rays are close together, and they are longer and thicker than the rest. The dorsal fin starts at the level of the sixth vertebra and no pterygiophores are observed. The pectoral fin is in a low position in the body near the ventral edge, and has 10 rays. The pelvic fin initiates at the level of the last dorsal fin ray as in Strangomera and Clupea. A series of 14 ventral scutes are observed, 12 of them are in the pre-pelvic region and two in the post-pelvic region. These scutes are ascending in the form of a keel and they do not reach the midpoint of the body as in the genus Clupea. The fish has a terminal mouth as in Dorosomatinae, one maxilla and two extended supramaxillae as Strangomera and Clupea. The dentary is smooth and toothless such as the premaxilla, a condition also present in Alosinids. The Muhi quarry specimen shares a number of features with Clupea, but bears a combination of characters present in other clupeomorph taxa that include: pectoral fin in low position, with 10 branched rays; scutes ascending in the form of keel; and dentary smooth and toothless. This combination of characters suggests that it belongs to a new species of the subfamily Clupeinae. The other clupeomorph fishes are not well preserved. There are two incomplete specimens where the head is missing, but the presence of a series of ventral and postdorsal scutes, suggests that they belong to the Ellimmichthyiformes.

PYCNODONTS AND ACTINOPTERYGIAN FAUNAL REPLACEMENT IN EUROPE DURING THE CRETACEOUS

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The analysis of the global diversity of the Pycnodontiformes reveals interesting aspects of the evolutionary history of this group, especially when their diversity is studied in comparison with their distribution and focused on the problem of how the actinopterygian faunas changed throughout the Cretaceous.

Overall, the history of pycnodonts as shown by their current fossil record is Tethyan-centered. They appear in the Tethys in the Late Triassic, radiating from there during the Jurassic so that, from the Tethys, they expanded to a nearly cosmopolitan distribution, especially during the Early Cretaceous: N & S America, Africa, and Asia. From the Late Cretaceous on, their geographical distribution decreases notably; all their later records occur only in the Tethyan area again, including their last confirmed record, from the Eocene. Interestingly, their taxonomic diversity and morphologic disparity are always unexpectedly high, even during the times when their geographic distribution is decreasing. Together with a review of their ecomorphologic plasticity, it suggests that they may have been more adaptable and competitive than previously thought.

The evolutionary history of the pycnodonts appears more intriguing when compared with that of the teleosteomorphs, or, to be more precise, when one tries to understand the reason why durophagous teleosts do not appear until the Late Cretaceous. Ecologically, teleosteomorphps are generalised forms that occupy the lowest levels of the trophic pyramid since their first appearance, around the Middle to Late Triassic, until their evolutionary radiation during the Late Cretaceous. This is especially clear in the Jurassic and Early Cretaceous faunas or Europe. If teleosts are so plastic and adaptable (which they are), it is difficult to understand why they are not competitive with pycnodonts for the durophagous niches during such extremely long time (some 125 my.). A similar thing applies to competition for the predatory niches, at least in the Cretaceous of Europe. The evolutionary processes involved are, no doubt, of an enormous complexity, so that some of them may have been a bit overlooked so far.

A current working hypothesis proposes that pycnodonts were actually more competitive than previously thought. Wherever pycnodonts were present, durophagous teleosts did not appear; they only did when a major environmental event took place. Only under radically changing conditions would teleosts be more competitive than pycnodonts, and therefore able to replace them. This is suggested by the general distribution and diversity of pycnodonts, but a more detailed analysis is, of course, indispensable. The Cretaceous is a key period for this faunal turnover in the Tethys and the peritethyan area. In order to test this hypothesis, a detailed mapping of the distribution and environments of the fossil record of pycnodonts versus durophagous teleosts in relation with the marine transgression in Spain during the Cretaceous will be attempted in the forthcoming years. Similar major events may be related with such faunal replacements in this or other time periods in Europe and worldwide.

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INTERNAL SOFT ANATOMY AND ORGANIC FLUID-LIKE PATTERN PRESERVED IN FISHES (CLUPEOMORPHA) FROM TLAYÚA LOWER CRETACEOUS LAGERSTÄTTE, MÉXICO

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Early Cretaceous fishes of Tlayúa Lagerstätte seem to suggest distinct stages of death and decay. Specimens typically appear flattened within reddish laminar interfaces of micritic limestones strata. They show remarkable morphological details and reveal internal soft parts exceptionally preserved as degraded organic tissues crystallized by early diagenetic phosphates. Fishes have fully articulated carcasses and internal structures such as stomach, intestine, gonad, gills, liver, swing bladder, multinucleated muscle cells and blood vessels. These tissues are preserved three-dimensionally and some are fully mineralized.

The aim of the present work is to investigate the molecular taphonomy of internal soft parts preserved in clupeomorphs through the use of ultraestructural and biogeochemical analytical methods based on Atomic Force Microscopy, SEM, ≥-XRD, PIXE and Raman spectroscopy. The result shows a characteristic pattern of trace elements preserved in soft tissues of these fishes, including Si, P, Ca, Fe, Na, Mg, K ,Cr, Mn, Zn, As, Sr, Mo, and Ba, which are used here as fossil fingerprints of organic preservation. Also we observed that crust and molds of organic fluid-like are preserved as amorphous clusters of iron oxide microcrystals and degraded organic molecules. Likely, the internal soft parts were preserved by a spontaneous reaction in a marine system supersaturated with biogenic apatites, occurred within the sediments pore water.

Fossilized soft tissues offer the rare opportunity to investigate into the ancient fish physiology. In this way, the remarkable soft-tissue preservation makes Tlayúa Quarry one of the most emblematic Lagerstätten for North America. In addition, this locality has a significant set of fish taxa documented with systematic and biogeographic implications. This certainly allows the best insight into the marine life during the Lower Cretaceous.

THE CAUDAL SKELETON OF TELEOSTS: REVISITED

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Non-teleostean actinopterygians possess a polyural caudal skeleton, where each epaxial neural arch and hypaxial hypural corresponds to one vertebral ural centrum. Pholidophorus bechei and other “pholidophoriforms” present a polyural caudal skeleton. In contrast, in adult “true” teleosts (Leptolepis coryphaenoides + more advanced teleosts) the polyural caudal skeleton, or the one-to-one relationship between ural centra and dorsal and ventral elements, is reduced to a diural skeleton, where the remaining epaxial elements and the hypurals are related to two or less ural centra.

The developmental transformation to a diural skeleton is different in different teleost groups, and therefore is useful as taxonomic and phylogenetic tool. For example, the so-called first ural centrum in adult clupeomorphs represents the ural centrum 2, ural centrum 1 is not formed so that hypural 1 has no articulation with the so-called first ural centrum and the so-called second ural centrum may correspond to the fusion of ural centra 3 and 4 or even more centra. The correspondence of hypurals and ural centra is a useful tool to identify homology in ural centra, if the ontogeny is not known. Traditionally, the dorsal elements in the caudal skeleton (epurals and uroneurals) are sequentially numbered in the diural terminology. However, these numbers do not correspond to homologues in contrast to the ventral series of elements. The first epural can correspond to the neural spine of the preural centrum 2 or 1 or to the neural spine of the ural centrum 1, 2 or 3. A similar problem arises with the homologization of the uroneurals that are paired structures that result from modifications of ural neural arches. For instance, the so-called first uroneural or stegural corresponds to the neural arch of ural centrum 4 in salmonids, whereas the first uroneural may correspond to ural centrum 1 or 2 in clupeomorphs and some cypriniforms or to ural centrum 1 in some of the Jurassic basal teleosts such as Leptolepis coryphaenoides and Ascalabos voithii. An additional problem results that in some groups (e.g., pachycormiforms, aspidorhynchiforms and certain so-called “pholidophoriforms”) all —or some of the—elements traditionally named as uroneurals are the result of a modification of a preural neural arch, not of an ural neural arch, unlike the condition present in all “true” teleosts.

New evidence concerning the polyural caudal skeleton of early ontogeny will be presented, and the problem of homologization of structures will be discussed in selected fossil and recent teleostean groups.

THE BASINS OF THE LITHOGRAPHIC LIMESTONE OF SOUTHERN GERMANY AND THE RISE OF NEW FISH GROUPS

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The Plattenkalk basins in the southern Franconian Alb during the Late Jurassic times can be interpreted as part of a big lagoon with connection to the Tethys Sea a somewhat different situation in comparison to strict continental lakes. Another difference is that not all basins in the Plattenkalk are identical in age; that is an important element in the understanding of the diversification of taxa and of their fate from older to younger basins. We will analyze here whether the Solnhofen Plattenkalk basins show some common aspects with the speciation process shown in certain particular continental lakes or not.

We have studied the faunal composition, as far it is known, from selected basins (e.g., Ettling, Daiting, Schamhaupten, Solnhofen) and discovered three common points to all of them: 1) The best represented group in number of species as well as in individuals, is that of the teleosteomorphs, especially the “true” teleosts; (2) the taxonomy of many fishes is incompletely known. Nevertheless, the few good identifiable taxa demonstrate variation through time and from basin to basin; and (3) the knowledge of all localities is still incomplete as demonstrated by the discovery of new taxa. One of the best-known groups of the Plattenkalk basins are the teleosts. The Teleostei are represented by lineages that are extinct today, e.g., basal teleosts such as Tharsis and ichthyodectiforms, but also by basal members of the crown-group Teleostei such as the elopiforms, ostariophysans, and euteleosts. Our studies reveal that a few species, e.g., Tharsis dubius and Leptolepides sprattiformis are recovered from the Kimmeridgian to late Tithonian. However, they show intermediate morphological changes through time that make it difficult to interpret their evolving characters as part of a species in process of speciation or as new species when these species are closely examined. In contrast, there are other species, e,g., Orthogonikleithrus leichi and O. hoelli, that show a very local distribution, lived for a very restricted period of time, but they stand at the base of the most successful line of teleosts, the Euteleostei. Others like the elopiforms (e.g., Anaethalion, Elopsomolos) had their most important radiation in the Late Jurassic, in the Plattenkalk basins, and in contrast to the euteleosts, the group survives today with few species.

Thus, studying the individuals of a potential taxon locally, and then comparing them with similar individuals throughout time will permit us to understand the variation involved and consequently the proper systematics of the taxon under study. The Plattenkalk basins offer this unique opportunity of local and temporal study of the taxa and their process of speciation. The age of the localities is critical for such studies, one million years makes a difference.

LATE TRIASSIC SEMIONOTIFORM FISHES FROM SOUTHERN UTAH, UNITED STATES

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The remains of ganoid fishes are abundant in the Upper Triassic Chinle Formation, particularly in the area of Lisbon Valley, north of Monticello, San Juan County, Utah. Fishes from this area were first described by Bobb Schaeffer in the 1960's, including several new species of fishes. Schaeffer recognized fishes of the family Semionotidae in the study area, but did not describe any taxa, merely mentioning the diverse array of body morphology displayed among the fishes. He had earlier described a new semionotid, Semionotus kanabensis, from a site near Kanab, Utah. Schaeffer referred this taxon to the Upper Triassic Chinle Formation, although the locality has been restudied and is now recognized to be the Lower Jurassic Whitmore Point Member of the Moenave Formation. Because Semionotus is currently defined by a mosaic of characters, none of which are unique to Semionotus, it is difficult to establish monophyly of the genus. Semionotus can be compared to closely related genera, including Lepidotes, Paralepidotus, and others. A comprehensive re-examination of the semionotids' characters, including the undescribed Chinle Formation semionotids, is necessary to establish the phylogenetic relationships of this group.

THE FIRST RECORD OF AIPICHTHYOIDEA (TELEOSTEI, ACANTOMORPHA) IN MEXICO

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The quarry "El Chango" is a marine-estuarine fossil site of Cenomanian age discovered less than a decade ago in the vicinity of Tuxtla Gutiérrez, Chiapas, southeastern México. Recently an acantomorph fish was discovered in this locality. A peculiar character of this Mexican fish is the occurrence of a very large sagittal crest beginning at the anterior edge of the orbit, extending posteriorly, overhanging the posterior border of the skull. After a comparative analysis of the anatomy of the new fossil fish with other Cretaceous acantomorphs, it is possible to conclude that the single specimen as far known is a new member of the superfamily Aipichthyoidea. Four synapomorphies identified in this specimen, support this taxonomical designation: the occurrence of seven pelvic fin rays, the thoracic position of the pelvic girdle, the absence of an antorbital, and the anterior process of the hyomandibular bone forming a plate. This record increases the geographical distribution of the superfamily Aipichthyoidea towards the western rim of the Tethys Sea.

NOT ONLY MONTE SAN GIORGIO: A NEW DEAL FOR MIDDLE TRIASSIC FISHES

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The most important localities for Middle Triassic Marine Vertebrates are concentrated in two areas: the Alps - on Monte San Giorgio (Lombardy, Italy and Canton Ticino, Switzerland) - and Southern China - in the Guizhou and Yunnan Provinces. Through all the last century, Monte San Giorgio has represented the major fossil-bearing site concerning marine fishes of that age; this was certified by the III Mesofish Meeting held in Serpiano in 2001, and, most of all, by the inscription of the Swiss side of Monte San Giorgio in the Unesco World Heritage List in 2003. Monte San Giorgio (MSG) is unique in having several fish (and reptile) levels, spanning more than 10 Ma, in a really small area, even at walking distance. The age is from Late Anisian - bottom of the Besano Formation (Grenzbitumenzone) - to latest Ladinian - upper Member of Meride Limestone (Kalkschieferzone). Until few years ago, the fish fauna contained in the lower half of the Besano Formation was believed to witness the major radiation of ‘subholosteans’, which were considered the dominant actinopterygian group in the Middle Triassic to early Late Triassic. Perleidiformes and Peltopleuriformes, in a very broad sense, are very common across the MSG sequence and are among the most specialized fishes of their times (e.g., Colobodus, Felberia, Peltopleurus, Dipteronotus, Habroichthys, Luganoia, Ctenognatichthys), leaving the top predators Saurichthys and Birgeria apart since they span the whole Triassic. Neopterygians were regarded as small and rather uncommon in the Middle Triassic, with few exceptions, such as Prohalecites or Allolepidotus. Typical Mesozoic non teleostean-neopterygian groups like Semionotiformes, Pycnodontiformes, "Pholidophoriphormes" were known to appear only in Late Triassic, with a major radiation in the Norian (the Zorzino Fauna). Only recently a sure semionotid fish was described from the latest Ladinian; named Sangiorgioichthys, it was considered the oldest genus of the group, though very rarely found compared to most of the subholosteans of its association. Thus, three major Triassic faunas represent the actinopterygian recovery after the P/Tr crisis: the almost cosmopolitan ‘Early Triassic fauna’ with several paleopterygian groups and Parasemionotiformes for the basal neopterygians, the ‘Middle Triassic fauna’ (late Anisian-Carnian) dominated by the subholosteans and, finally, the ‘Late Triassic fauna’ starting from the Norian, when Neopterygians won the day, and thenceforth remained the most common fishes, especially after the origin of teleosts.

The new century brought something really new and unexpected: Pelsonian (Middle Anisian) beds from different sites of southwestern China yielded many new neopterygian taxa together with a few subholosteans and other basal actinopterygians. The new Pelsonian fauna shows that neopterygians and subholosteans had an almost contemporaneous radiation following the decline of the typical Early Triassic fauna. However, after some of the new taxa migrated westwards, the two sides of the Tethys had somewhat different histories regarding actinopterygians, at least throughout the remaining Middle Triassic time.

[Among others, many thanks to Cristina Lombardo, Jiang Da-Yong and Sun Zuo-yu.]

A NEW ANISIAN (MIDDLE TRIASSIC) FISH-LEVEL NEAR DAWAZI (LUOPING COUNTY, YUNNAN PROVINCE, P.R.CHINA): DATING THE POST PERMO/TRIASSIC CRISIS REAPRISAL

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A new fish level has been recently discovered in the hills around the village of Dawazi, about 20 km SW of Luoping County (Yunnan Province, Southern China). The age of this fossil fish assemblage is Pelsonian (Middle Anisian) and may be considered more or less coeval to the Panxian Fauna (Guizhou Province). This latter is well known especially for marine reptiles, while fishes are rare and usually not well preserved, but the new fossiliferous levels near Luoping are actually so rich in very well preserved fishes that they can be easily considered one of the best fish-levels of all the Triassic.

So far more than 20 taxa have been detected, a few of them already known at least at genus level in Western Tethys localities (mainly Monte San Giorgio and surrounding Middle/Late Triassic localities in Northern Italy and Southern Switzerland) and/or in the Panxian Fauna. Though from both the Panxian fauna and a small fish fauna in the Braies Dolomites (N. Italy) it was already clear that the first radiation following the Permo/Triassic crisis was already taking place in the Pelsonian, the new Luoping assemblage witnesses this major radiation involving all the actinopterygians such as specialized paleopterygians (Saurichthys and the subholosteans) as well as the neopterygians. At genus level, the neopterygians are just somewhat less in number than the paleopterygians, however outnumbering the subholosteans or the other basal actinopterygians kept alone. Several taxa are represented by very nicely preserved specimens, allowing detailed description so far prevented by the somewhat poor preservation in many Western Tethys sites. As a few taxa are in common to the Western Tethys, it is becoming clear that migration ways were available, at least temporary, in the Middle Anisian and later on during the Ladinian. However, Western and Eastern Tethys Bioprovince also evolved endemic taxa, sometime showing parallelism in swimming and trophic adaptations or with very unique characters.

SHORT AND LONG DISTANCE DIVERSITIES IN THE FISH ASSEMBLAGES OF THE MIDDLE TRIASSIC

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The Tethydean Middle Triassic basins yield several sites which are very rich in marine vertebrates. The majority of localities are concentrated in the Central Alps [especially in Lombardy (Italy) and Canton Ticino and Graubunden (Switzerland)] and in Southern China (Guizhou and Yunnan Provinces): in between these two regions, so far only recently discovered sites in Slovenia are known. The two major fossiliferous areas show different paleoenvironmental settings. In the Alps there were several more or less coeval basins over short distance with each basin being somewhat different from the others, while in Southern China each single fossiliferous level is known from 100s km2 being furthermore very homogeneous in environmental conditions. Comparison between the faunas may be easy for the fishes, which are usually small and numerous. Therefore, the actual composition of each assemblage is achieved in a rather short time of field work. This is particularly important in the Alps where it is difficult to have very large bed-surfaces to be excavated, owing to tectonic; it can be considered that in the Monte San Giorgio area, in about 150 years of paleontological field work, no more than 1000 m2 have been investigated, considering all the different vertebrate levels. In many rich fish-levels we can argue that after investigating 20-40 m2 we have collected most of the fish fauna. With these assumptions, we can confidently compare most of the Middle Triassic fish fauna from the whole Tethys, discovering that a few genera are very widespread, others have been found only in each major region, and some are strictly endemic to a single locality. Among the ‘cosmopolitan’ genera are Saurichthys and Birgeria. This it is not surprising as we already knew that the two have a large distribution in time and space. However, some Saurichthys species are very specialized and endemic of each region, while others more ‘basic’ are very widespread. More surprising is that fishes among the smallest in the fossil record, such as Placopleurus and Marcopoloichthys (neopterygians) and Habroichthys and Peltopleurus/ Peltoperleidus (subholosteans) show the widest distribution, being furthermore very common. A few other genera seem to be also very widespread, even if we need more detailed studies to sustain that the species from Western and Eastern Tethys are congeneric. Many other genera had a more limited geographical distribution and in some cases this may be related to the evolutionary history of the single large region.

SECOND RECORD OF A COELACANTH FROM THE LOWER CRETACEOUS CRATO FORMATION, ARARIPE BASIN, NORTHEASTERN BRAZIL, WITH COMMENTS ON THE DEVELOPMENT OF COELACANTHS

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A well-preserved coelacanth fossil was yielded from the Lower Cretaceous Crato Formation, from the outcrops near the town of Nova Olinda, Ceará, Northeast Brazil. This is the second record of a coelacanth in this formation. The first specimen was a 70 mm total length, identified as Axelrodichthys sp. by Brito and Martill in 1999. The new specimen is almost complete, better preserved than the first one, although its caudal fin is partially disarticulated. This is a larger specimen with an estimated total length about 100 mm and the standard length is 73 mm. This coelacanth is identified as Axelrodichthys araripensis Maisey, 1986, based on the following characteristics: the dorsal outline of the head is concave, the deepest portion of the lower jaw is located anteriorly and the median extrascapular bone is present. Except from the two young individuals found in the Crato Formation, all other specimens of A. araripensis were found in nodules from the Santana Formation. It is difficult to compare all the characters present in our specimen to adult specimens, since most of the larger specimens from the Santana Formation are incomplete, and especially because entire fin rays are not preserved. It is interesting that the present specimen has relatively long fin rays a character found in juveniles of some actinopterygian fishes (e.g., Platax spp., Caetodon spp.). The ratio of head length / standard length is larger than that of adults. The long fin rays and the larger head are characteristic of juvenile of this species. A most interesting thing is that the lung is already covered with calcified thin plates at this stage.

The fact that the specimens of Axelrodichthys from the Crato Formation are juveniles, as well as specimens from other species also found in the Santana and the Crato formations (e.g., Placidichthys, Santanichthys, Cladocyclus,) led us to suggest some paleoecological implications related to the reproductive biology. Considering that the paleoenvironmental condition of the Crato Formation are currently interpreted as lagoon-like with probably fluctuating salinities, it can be suggestive that marine forms had entered the lagoon through one of the restricted links to the sea, perhaps for reproduction.

A FISH FAUNA FROM UPPER CRETACEOUS OF SONGLIAO BASIN, NORTHEAST CHINA

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The Songliao Basin in northeastern China is the largest Cretaceous oil-gas producing basin in China, with the giant Daqing Oilfield situated in its central part. Unconformably overlying the basement, about 4000 m thick Mesozoic and Cenozoic terrestrial deposits are unevenly distributed across the basin. The Cretaceous sedimentary rocks are mainly composed of clastic rocks, intercalated with oil shales, shales, and volcanic rocks. The Upper Cretaceous strata, in an ascending order, includes the Qingshankou, Yaojia, Nenjiang, Sifangtai, and Mingshui formations.

The fauna from Songliao Basin include eight fishes, Manchurichthys uwafoko from the Qingshankou, Plesiolycoptera daqingensis from the Yaojia, Sungarichthys longicephalus, Jilinichthys rapax, Hama macrostoma, an osteoglossomorph, an amiiform fish, and a tooth of Selachii indeterminated from the Nenjiang formation. In recent years, abundant and well-preserved fish specimens have been collected from the Nenjiang Formation of the central part of the basin. Among the findings there are: an osteoglossomorph fish that was previously unknown from the Nenjiang Formation, and an amiiform fish that is the first occurrence found in the Upper Cretaceous of the basin. Manchurichthys uwafoko (Salmonifomes incertae sedis), mainly found in the adjacent Yanji, Luozigou and Jiaohe basins, was formerly represented only by detached bones in Songliao Basin. Recently, several complete skeletons as well as rich disarticulated bones of this species were discovered from the Qingshankou Formation. Based on the new specimens, the nature and the paleoenvironment of the fish fauna are discussed and Manchurichthys uwafoko and Sungarichthys longicephalus are redescribed.

FIELD TRIP TO THE TLAYÚA QUARRY

Luis ESPINOSA-ARRUBARRENA & Jesús ALVARADO-ORTEGA

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Itinerary
(see Figure 1)

First day, July 30th

7:30 Departure from Instituto de Geología, UNAM in México City

10:30 Arrival to the “Museo Regional Mixteco: Tlayúa”, Colonia Morelos in Tepexi de Rodríguez (particularly, the Shelton Applegate Hall).

10:30-11:00 Visit the museum for an introduction to the Tlayúa Quarry; general aspects of what is known as La Mixteca Poblana and we will meet the Aranguthy family, the quarrymen and owners of the land where Tlayúa is located.

11:15-12:30 Visit to the Tlayúa Quarry – This is the site where over 6,500 fossils have been recovered in the last 25 years. We will try to have some workers demonstrating their exploitation methods and how the fossils reach the Paleontological Collection of the Geological Institute.

13:00-14:45 Lunch at the “Museo Regional Mixteco: Tlayúa” with the Aranguthy Family, our local hosts.

15:00-16:00 Visit to “Pie de Vaca” locality, vertebrate tracks and traces. Located some 300m south of the Regional Mixtec Museum, these ichnofossils occur in several layers of a lacustrine limestone that represents the shore of a large lake. The outcrops that bear the footprints belong to the Pie de Vaca Formation, dated by Pantoja-Alor (1992) as “Late Tertiary-Early Quaternary” (Plio-Pleistocene); although, based on the stratigraphic relationships with “Los Ahuehuetes” (a nearby Paleogene plant locality), for some paleontologists the footprints should be considered much older (Eocene-Oligocene).

The Pie de Vaca site corresponds to a 200 m^2 slab that bears around several hundred footprints arranged in very distinct tracks and traces, all moving in different directions. From these, nine trackways of small llama-like camelids, three of large felids and a single trackway of a small ungulate (a possible dwarf pronghorn) have been identified.

Besides these remarkable fossil prints, a unique fossil should be mentioned; this is the impression of a skeleton (taphoglyph) of a small flamingo, stepped on by one of the llamas (Cabral Perdomo, 1995). In 1994, the taphoglyph was removed to avoid its destruction and since then, the specimen has been housed at the Paleontological Collection of the Instituto de Geología, UNAM (Colección Nacional de Paleontología). At the spot where the taphoglyph was removed, the community of Tepexi de Rodríguez-Colonia Morelos erected a monument that depicts a bronze cast of the "stepped-on flamingo".

Departure from Tepexi de Rodríguez to the town of Tepeaca, Puebla, where we will spend the night.

18:30 Arrival at the Hotel Campestre María Isabel Tepeaca, Puebla.

Tepeaca

This town, founded in 1520 is 40 km east from the City of Puebla. Tepeaca is the Spanish word of Tepeyacac that means "on the top of the hills". In the main plaza there is a house with a commemorative inscription that mentions that here, Hernán Cortés wrote the "Segunda Carta de Relación" to the King Carlos V. In this town there are two important buildings: a Franciscan Convent of the XVI-XVII Centuries; and also the "Rollo" (The scroll) where the death sentences were read and confirmed during Colonial Times.

19:00-20:00 Light supper at Hotel Campestre in Tepeaca, Puebla.

Second day, July 31th

7:30-8:30 Breakfast at Hotel Campestre.

8:45 Departure to the town of Tepexi de Rodríguez and the archeological site of "Tepexi el Viejo" (old Tepexi).

11:30-12:45 Visit of the archeological site of Tepexi el Viejo (information partially obtained from Applegate, 2000).

Located some 8 km west of the Town of Tepexi de Rodríguez, Tepexi el Viejo represents one of the most important archeological sites in the Pueblan Mixtec. Tepexi el Viejo was originally named *"Tepexic*" or "the place of cliffs" (from the Nahuatl *tepexic* = *tetl*-stone and *pexic*-broken, as in cliffs).

The early settlers at Tepexi el Viejo were a group of Popolocas that during the Classical Period were dominated by the Teotihuacan Empire. Archeological investigations within the area have shown that at this time period (250-500 AD) the famous **Thin Orange Ceramic** was manufactured in a town close to Tepexi de Rodríguez, near the Río Carnero. At this stage of the imperial expansion, "Thin Orange" was widely distributed by means of the Teotihuacan emissaries that together with the exportation of the "obsidian warfare" dominated Mesoamerica.

During the XV and the beginnings of the XVI Centuries, the site became an undefeatable fortress and an obligated pass of the trading routes of the Central Altiplano (Mexican Tableland) with the Mixtec area and the central valleys of Oaxaca and parts of Veracruz, Tabasco and Yucatán. Due to its importance, the Central Empire of the Mexicas (Aztecs), by means of what is known as the Triple Covenant (La Triple Alianza), fostered the marriage of Memotzopinatzin, a sister of one of the lords of Tlatelolco with the cacique of *Tepexic*. With this pact, the Mexicas obtained the absolute trading control of the Southeastern Commercial Route in Mesoamerica. This period is known as the constructive epoch of the site, around 1460 AD.

From the beginning of the construction of the fortress, the Popolocas chose a strategic place that consists of a rocky ridge surrounded by three deep cliffs (the Nahuatl name of the site describes this condition). The construction of the building was planned as a citadel (not a shrine), confined by massive outer walls as much as 60 feet high, with formal gates and special shelters for the guardians. In the upper level of the complex there are several plazas (or squares), two lower mounds (interpreted as small temple bases) and the general area is so large that it comprehends at least eight terraces, possibly used for agriculture purposes. The lower level was dedicated for the residences of elite soldiers, priests, and aristocracy.

After the Spanish Conquest, the population was removed from the fortress and established in a new village (where Tepexi de Rodríguez is today). At this time the Spaniards began the **Silk Industry** and the region became the first silk producer in the Puebla´s Intendancy (Province), as well as the first in the American Continent. Due to this emergent industry, the original name of the town was changed from *Tepexic* to "Tepexic de la Seda" (Tepexic of the Silk). Besides the silk industry, the exploitation of lacustrine limestones or travertine also started and today this activity is an important financial source in the region.

After the Colonial name of Tepexic de la Seda (Tepexic of the Silk), in 1860 the Intendency of Puebla changed the name of the town to "Villa de Tepexi de Rodríguez", in deference to Don Prudencio Rodríguez, a courageous liberal colonel who was born in Tepexic and died in the Battle of Coayuca in a national conflict that is known as the War of Reform (from December 1857 to January 1861). This Mexican civil war was fought between the Liberal and Conservative elites that emerged in the recently independent (from Spain) México. The main determinant of this war was centered in major discrepancies and dissatisfactions of the Liberals with the Catholic Church´s stronghold on government and economic affairs. The conflict involved the forced establishment of the brief IInd Mexican Empire of Maximillian of Hasburg. At the end of the war, the Liberal Party, leaded by President Benito Juárez, defeated the opponents and established the basis of modern México.

13:30-15:30 Lunch at the Museum, with the Aranguthy Family.

15:40 Departure from Tepexi de Rodríguez (Colonia Morelos) to México City.

19:00. Arrival to the Instituto de Geología in México City.

End of Field Trip.

Note: All times calculated for this itinerary are approximations and will be adjusted according to the local conditions.

Welcome to Tepexi de Rodríguez, a treasury in the Mixteca Poblana

For over 25 years researches of the Geological Institute, UNAM have developed an ongoing paleontological project in this isolated area of the State of Puebla. Along this period we have been able to witness the hard conditions in which the inhabitants of this part of México live. Nevertheless, the love for their culture and their strong ethnical roots (Mixtec, Popoloca and Nahuatl) represent an example of pride and self-esteem hard to find elsewhere in the country. Welcome to what Shelly Applegate used to call “The Oz” of México, known to the locals as the “Mixteca Poblana”.

Within the Municipality of Tepexi (a Nahuatl word that means a place with cliffs and rocks) we can find several examples of very old “cave paintings” and tens of archeological sites that range from the Classic Period to the Spanish Conquest. In nearby areas the archeologists have discovered the ovens of the famous ceramic known as “Thin Orange” (Anaranjado Delgado) one of the most priced objects, at the summit of the Teotihuacan Culture. After the Spanish Conquest, Tepexi was also known for being one of the first centers in the American Continent that developed the culture of silk (Tepexi de la Seda) (Figure 1).

Regarding Paleontology, in the Tepexi de Rodríguez area several interesting paleontological sites outcrop. These localities represent at least three geological ages characterized by the presence of well preserved fossils.

In this regard, Tlayúa is noticeable due to the unusual excellent preservation of its fossils, which since its discovery encourage that this Early Cretaceous North American Konservat-Lagerstätte locality was called as the “Mexican Solnhofen”.

From these sites, the youngest age corresponds to the Pleistocene and here we find the remains of horses, mastodons, glyptodonts and other continental mammals characteristic of what is known as the “Megafauna”. Another Cenozoic outcrop is known as “Pie de Vaca” (cow foot). Here, a large number of footprints, forming tracks were discovered many years ago. At this place, the specialists have identified camel (llama type) and felid footprints. This is one of the most famous sites in the area; this locality is so important that the original name of the museum we are visiting was “Museo Pie de Vaca” (or Cow Foot Museum).

Regarding Cenozoic Plants, there is a locality called “Los Ahuehuetes” that represents the remains of an Eocene lake, which produced a diverse flora that “left” an interesting fossil record of leaves, fruits and even flowers almost perfectly preserved. The Mixteca Region, where Tepexi de Rodríguez is located, is full of archeological sites, such as the Popolocan fortress preserved in Tepexi el Viejo, interesting cave paintings (as the ones known as Manos de Bruja), and many other natural and historical places ready to be re-discovered

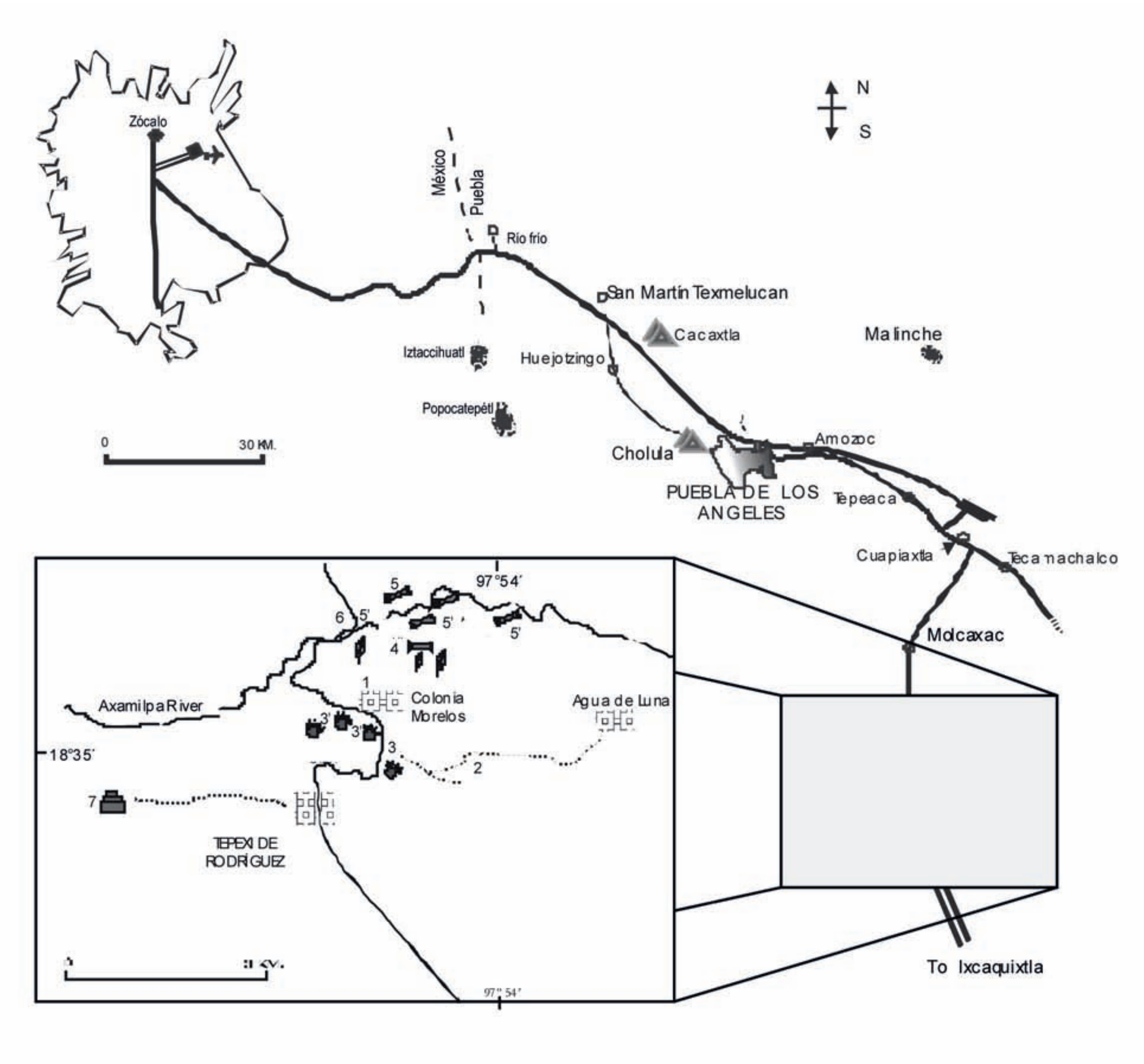

Figure 1. Map and location of the main attractions on the tour. 1, Museo Regional Mixteco; 2, Tlayúa Quarry; 3, Pie de Vaca and (3´) other vertebrate foot-print localities; 4, Fossil plant locality Los Ahuehuetes; 5, Glyptodont hill and (5´) other Pleistocene fossil mammal localities; 6, Prehispanic cave paintings Manos de Bruja (witch hands); 7, Tepexi el Viejo (Prehispanic Fort inhabited by Mexicas and Popolocas).

Finally, the Nahuatl word “Tlayúa” means “the place of dawn”, and so we thought when it was first discovered many years ago, because it represented the first light of a large and brilliant future of paleoichthyology in México. The Tlayúa Quarry is the most important locality not only in the area, but within the Country and unique in North America, due not only to biological diversity and richness of its fossil assemblage, but since this is an extraordinary window into the life that developed in the bio-rich tropical waters of the Tethys Sea. These fossils have helped fill important gaps in the phylogeny of different fish and reptile groups, at the same time have joined the record on the temporal and geographical distribution patterns of these taxa in areas of southern North America that during the Early Cretaceous represent the western limit of the Tethys Sea and the connecting point between other important and well-known fossil fish areas at North America, South America, and northern Africa.

Although different positions have recently arisen regarding the age of the fossil bearing strata of Tlayúa quarry, the best documented agree that these are of Albian age. Tlayúa Quarry fossil assemblage is very important not only for its high diversity that includes over 100 groups above familiar level, of which many genera and species must still be described, but also for the extraordinary preservation features of its fossils (mainly in fishes). We have discovered fishes with the eye's lens, and it is comparatively common to find soft parts preserved with muscle fibers, endothelial, epithelium, complete gill rakers and lamellae, among other tissues. Also many fishes show their intestinal contents and even microbial (bacteria and fungi) activity has been detected in some of the specimens.

The Regional Museum: Tlayúa and the Aranguthy Family

In 1959, Don Miguel Aranguthy (The patriarch of the family) started the quarry operations in the Tlayúa ravine (Figure 2). This area; not larger than four football fields, is located 2.5 km northeast from the town of Tepexi de Rodríguez was inherited from his grandfather Anselmo.

After several months of quarrying in Tlayúa, Don Miguel and his sons Félix, Faustino, Ranulfo, Sebastian, and Benjamin noted with surprise that this place produces more than slabs of limestone in a unique red color, but also beautiful fossil fishes that appear from time to time. This condition was highly unusual in the area because none of the other travertine quarries produced fossil fishes, and they (The Aranguthy) were aware that the ocean (Gulf of México) was at least 300 km to the east of their home. Nevertheless, Don Miguel and his children had the curiosity and natural instinct that "told" them that these "objects" had an immense scientific value and that they should start the quest for finding somebody that could explain the "strange" presence of these creatures in the stones.

In 1982 a group of paleontologists and geologists from the Instituto de Geología, UNAM, led by Dr. Applegate established a cooperative agreement with the family Aranguthy (Figure 2). Since then, as part of this joint project, over 6500 fossils have been recovered. Almost all these paleontological materials are perfectly housed at the Institute's Paleontological Collection (Colección Nacional de Paleontología), with some few exceptions the majority of the specimens are concentrated within this National Collection and available to paleontological research.

This cultural asset was developed as a request of Don Miguel Aranguthy and his family. As a stepping stone, it was agreed that the fossils were never sold, and that a small museum was built to share this paleontological wealth with the community of Tepexi de Rodríguez, as well as any visitor interest in paleontology.

This museum represents a number of small but steady stages that still requires one or two more halls that will house anthropological and historical materials from the Mixteca area. It was originally inaugurated in 1989, with the name of "Pie de Vaca Museum" (Cow's foot Museum), due to the nearby locality with camel-like foot prints and the interesting flamingo "taphogliph". This is what we are visiting today under the new name of **Museo Regional Mixteco: Tlayúa**. In the future we will develop at least two more halls.

So far, the Regional Mixteco Museum: Tlayúa displays: fossil fishes, reptiles and marine and terrestrial invertebrates from the Tlayúa Quarry. There are also the fossils of flowers, leaves, fruits and seeds from the Cenozoic (Eocene) locality “Los Ahuehetes”, as well as horse teeth, fossil wood, mammoth molars and other proboscidean remains found in Plio-Pleistocene localities. All of these fossils found in an area not larger than 10 km^2. This museum receives between 18 and 20,000 visitors each year.

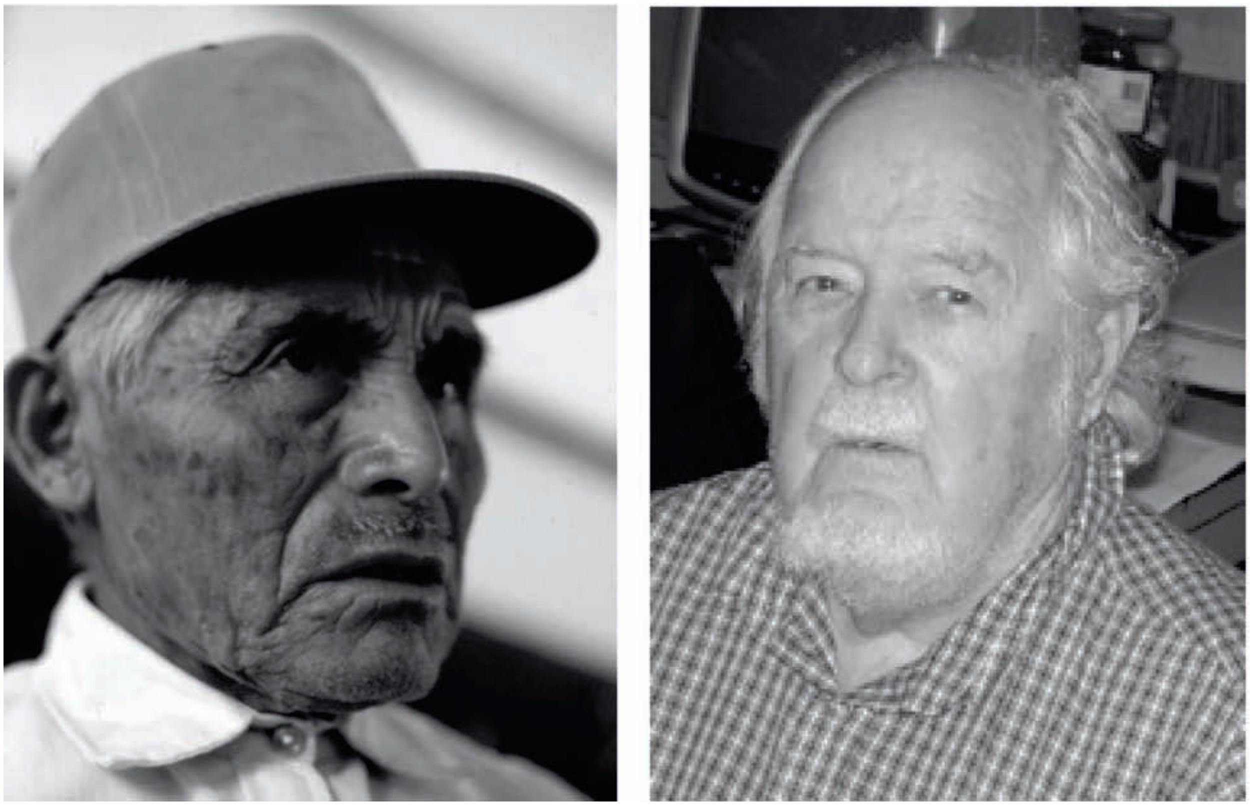

Figure 2. The discoverers of the Tlayúa Quarry. Left, Don Miguel Aranguthy (January, 1985); Right, Shelton Pleasants Applegate (January, 2005).

GEOLOGICAL ASPECTS OF THE TLAYÚA QUARRY

Regional geology

The Geological context of the Tlayúa Quarry has been discussed in Pantoja-Alor (1992) and more recently in Applegate *et al*. (2006). The area of Tepexi de Rodríguez lies within a region of Paleozoic (Cambrian-Ordovician) metamorphic rocks of what is known as the Acatlán Complex (Ortega-Gutiérrez, 1978). During Jurassic times this complex represented a positive land surface (Ortega-Guerrero, 1989), a condition that could have persisted until the Early Cretaceous (encompassing the time for the deposition of the Tlayúa beds).

Resting above the Tlayúa beds there is an unknown thickness of Cenozoic rocks that belong to the Pie de Vaca and the Agua de Luna Formations. From this last unit come the large travertine blocks that represent one of the most important economical sources of the region.

The Tlayúa Formation

According to Pantoja-Alor (1992) the Tlayúa Formation is a sequence of carbonates described on base of the outcrop exposed in the Tlayúa ravine, near Tepexi de Rodríguez. He subdivided the unit into three members (Figure 3). The base of this formation is not exposed and the top is truncated and covered by Tertiary continental sediments, the Pie de Vaca (Pliocene) and by the Agua de Luna (Pleistocene) Formations.

The Lower Member consists of at least 50m of bioturbated tightly folded bluish gray micritic limestones. Throughout the unit there are numerous beds with miliolids and it is capped by an undescribed mollusk fauna of very small bivalves and gastropods (Espinosa-Arrubarrena & Applegate, 1996). The presence of the rudist *Toucasia polygyra* and the bivalve *Chondrodonta* characterize this member. The biostratigraphic ranges of these mollusks sets this subunit within the lower Albian (Alencáster, 1973).

The Middle Member of the Tlayúa Formation corresponds to what along this field guide has been and will be called "The Tlayúa Quarry". It is the most important unit due to its numerous and diverse fossil assemblage. The sequence is about 35m thick and consists of multiple laminae of extremely fine-grained, yellow-brown micritic lithographic limestones (Figure 4). The bedding planes show very distinctive reddish-yellow to purplish-red hematitic layers, which bear a large array of exceptionally well-preserved and articulated fossils. Horizontally, this unit measures around 700m. And it is bounded to the west by an over thrust, and to the east it is covered by vegetation. This Middle Member is characterized by a large, rich and beautifully preserved paleobiota composed by: Cyanobacteria, calcispherae, calcareous nannoplankton (undeterminated) foraminifera, fungi, sponges, annelids, gastropods, ammonoids, belemnoids, bivalves, arachnids, crustaceans, insects, echinoids, asteroids, ophiuroids, fishes, reptiles, algae and terrestrial plants (see Applegate, 1987; Espinosa-Arrubarrena & Applegate, 1996; Alvarado-Ortega, 2005; Applegate *et al.,* 2006; among others) (Figure 5).

Within the fauna of this Middle Member it is important to mention the presence of the ammonite genera *Mortoniceras*, *Hystoceras* and *Anisoceras*, as well as several species of the belemnite *Neohibolites* that place this unit between the early and late Albian (see Cantú-Chapa, 1987; Seibertz & Buitrón, 1987; Seibertz & Spaeth, 2002).

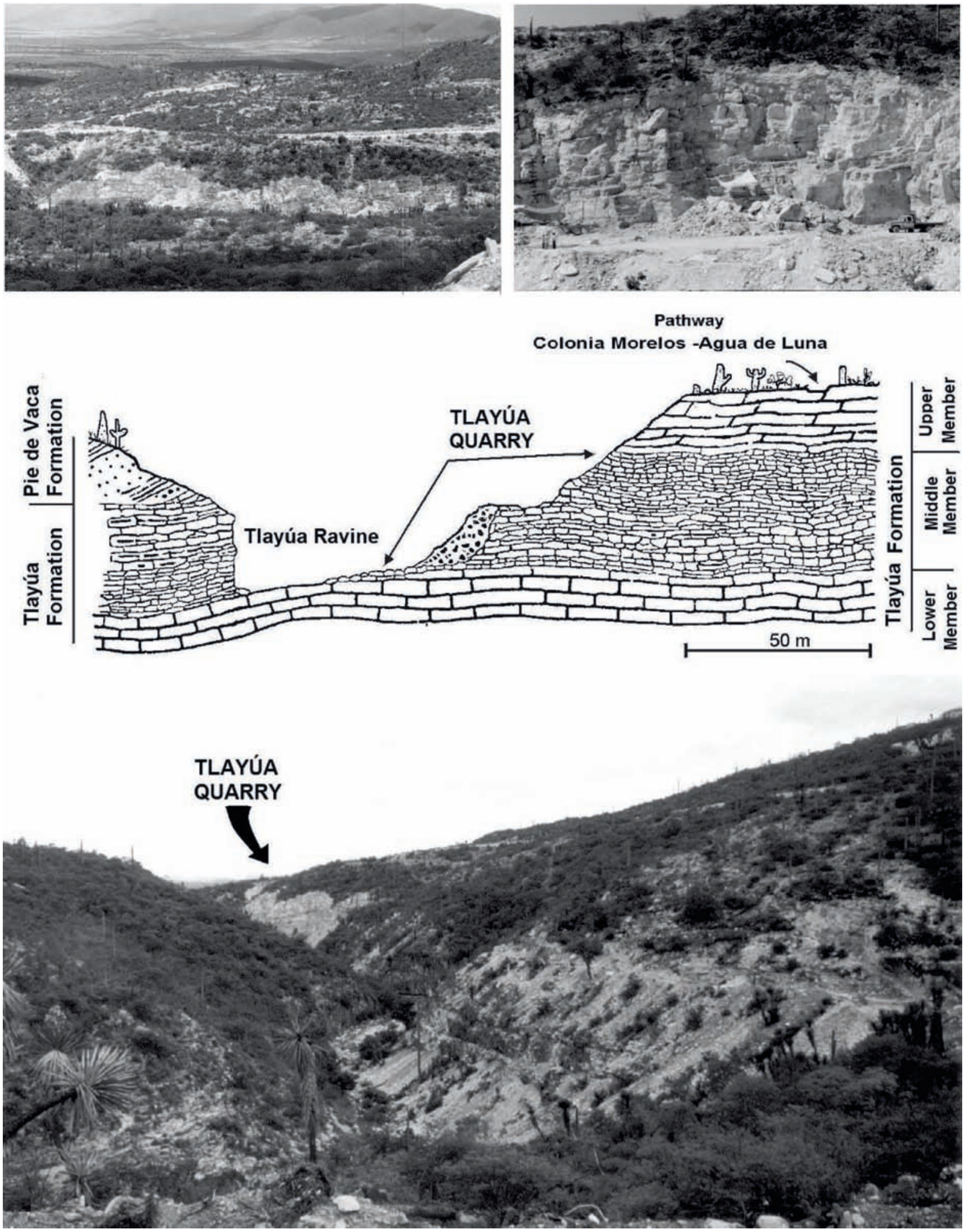

Figure 3. The Tlayúa Quarry. Top, a general view and a close-up taken from the East. Middle, Profile of the Tlayúa Quarry showing the three members of Tlayúa Fm. (modified after Pantoja-Alor 1992). Bottom, a general view of the Tlayúa ravine taken from the North.

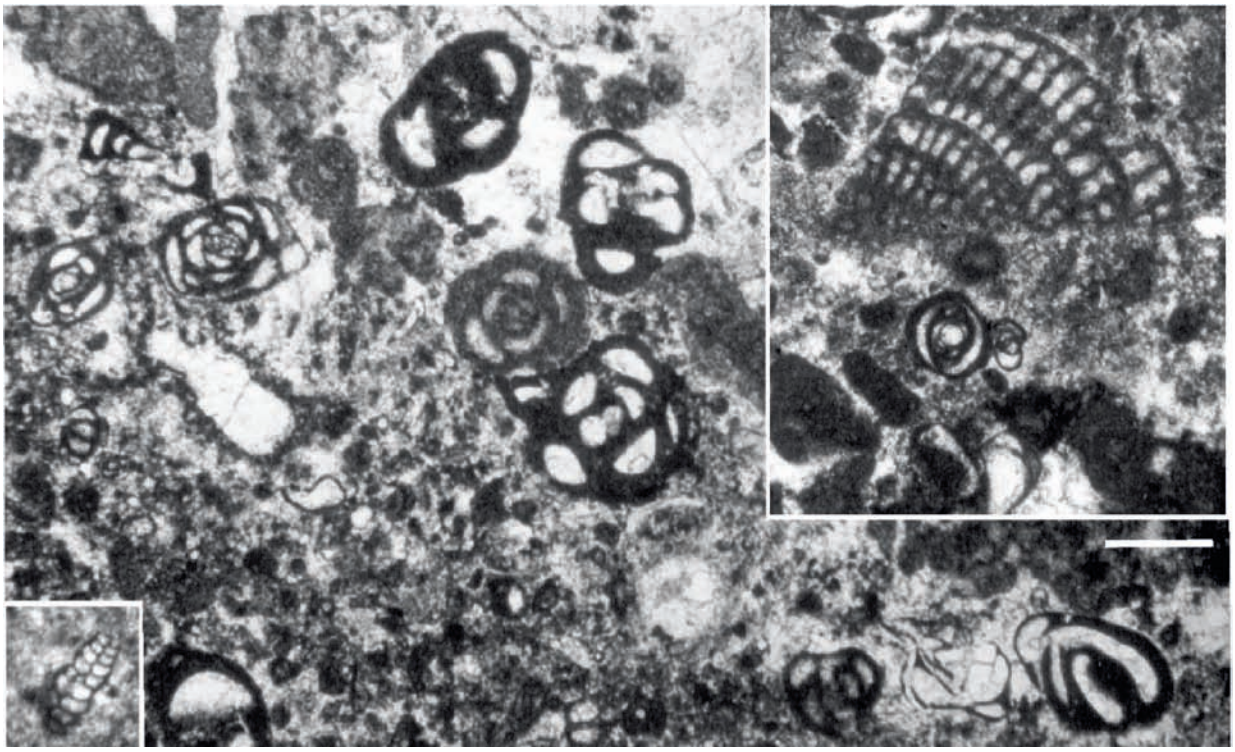

Figure 4. Thin section of micritic limestone from the Middle Member of Tlayúa Formation (miliolid foraminifera are abundant in these strata).

Parallel to the age assignment derived from paleontological studies, Applegate *et al*. (2006) reported a magnetostratigraphical analysis performed in a vertical section of the Tlayúa Quarry, including 95 samples from 31 horizons. In this study the magnetic properties of the Tlayuan limestones seem to correspond to C34n.1n – C34n.2n chrons, with an age of 100 to 105 m.y. for the Middle Member of the Tlayúa Formation. A time period that is consistent with the European biozonation of the ammonite species *Mortoniceras inflautm*, some of the taxa originally considered in assigning the age of this unit as late Albian (see Cantú-Chapa, 1987; Benammi *et al.,* 2004; Benammi *et al*., 2006). The age of this member has been challenged by Kashyama *et al*. (2004), who based on benthic foraminifera, suggested that Tlayúa should be lower Aptian. However it has been shown that some of their reported species have large stratigraphic ranges that exceed the Aptian, and even reach the end of the Albian (for a more detailed discussion regarding the age assignments of Tlayúa see Applegate *et al*., 2006). Other authors (Pi *et al*., 2008; Martínez-Hernández & Ramírez-Arriaga, 1999) have suggested that Tlayúa fossils could be Aptian or even Cenomanian in age; however, the evidences supporting these ideas have been discussed only superficially and have not been published in detail.

Finally, the Upper Member of the Tlayúa Formation consists of an incomplete sequence of gray dolomites whose age has been considered as Cenomanian due to the presence of the miliolid species *Dicyclina schlumbergeri* (Fernández-Becerra *in* Pantoja-Alor, 1992).

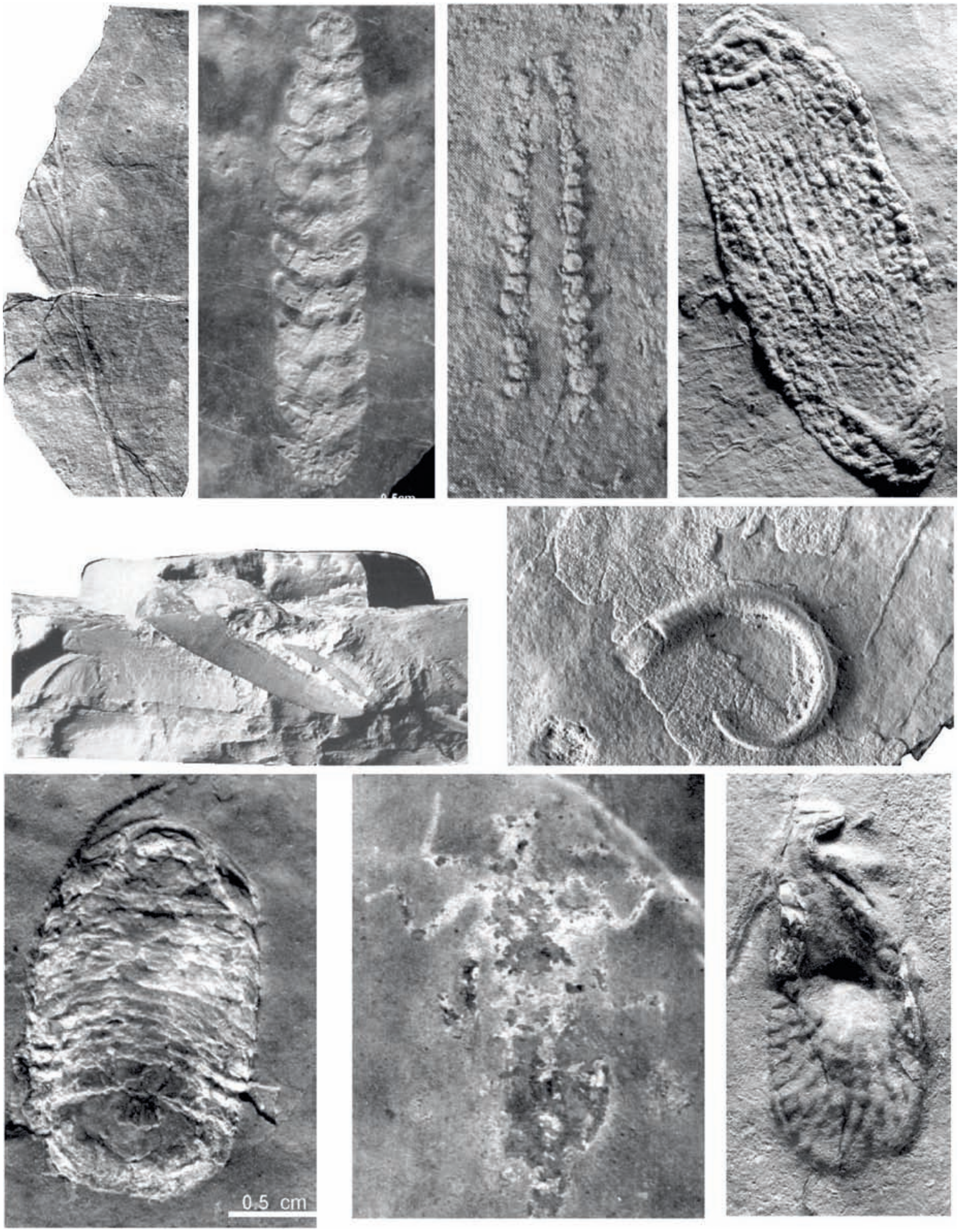

Figure 5. A small sample of the fossil diversity found in the Tlayúa Quarry from top to bottom and left to right, soft coral, plant, inchnofossil, holoturoid, belemnoid, ammonite, isopod, insect, and bivalve.

Paleoenvironmental Models of Tlayúa

Since the Tlayúa Quarry was first reported by Applegate & Espinosa-Arrubarrena in 1982, one of the main goals in subsequent studies has been focused in elucidating the paleoenvironmental context that produced this extraordinary association known as the “Mexican Lagerstätte”.

The list of paleoecological models includes: Applegate, 1987; Martil, 1989; Malpica-Cruz *et al*., 1989; Pantoja-Alor, 1992; Espinosa-Arrubarrena & Applegate, 1996; Feldman *et al*., 1998; Kashiyama *et al*., 2004; and Guerrero-Arenas, 2004.

All the investigations mentioned above imply several interesting ideas, however some very contrasting. In general terms the models include:

A) A shallow coastal lagoon (intertidal zone) behind a barrier reef connected to the open sea that was influenced by long desiccation (see Pantoja-Alor, 1992; Feldman *et al*., 1998).

B) A shallow water back-reef lagoonal interpretation, similar by comparison to Solnhofen the well-known Jurassic locality and in some ways similar to the previous model (see Applegate, 1987; Espinosa-Arrubarrena & Applegate, 1996; Suárez *et al*., 2009) (Figure 6).

C) As an open Marine Basin with storm-dominated sedimentation and bottom waters with restricted circulation (see Kashiyama *et al*., 2004).

The first two interpretations (A and B) imply the presence of a shallow coastal environment and conceive Tlayúa as a small lagoon, bounded to the east and north by great reef barriers (corals or rudists). Model (B) calls for a second (hypothetical) barrier towards the continent that divided the bio-rich reefal lagoon from the back-reef area, in which the sediments were deposited (Applegate, 1992; Espinosa-Arrubarrena & Applegate, 1996; Applegate *et al*., 2006). According to this model (B) the exceptional preservation of the Tlayúa fossils was due to a poor circulation system that caused anaerobic and/or hyper salinity within the back-reef lagoon that in times was completely isolated from the bio-rich lagoon or the open sea. According to Applegate (1992) there were seasonal storms, interpreted as double-monsoon influences from the northern and southern hemispheres by Kashiyama *et al*. (2004), in which the back-reef lagoon was overflowed and then supported a rich plancktic community, producing large quantities of calcareous ooze that in turn caused a rapid burial process.

The presence of diagnostic terrestrial and freshwater organisms including arachnids, insects, lizards, chelonians and land plants along with typical marine biotas suggest that the Tlayúa (back reef) lagoon had periodic freshwater inflow in addition to the strong, marine lagoonal and reefal influence (Feldmann *et al.,* 1998). The allochthonous nature of the deposit indicates that some organisms were transported into the back-lagoon when the barrier was breached, during the monsoonal season.

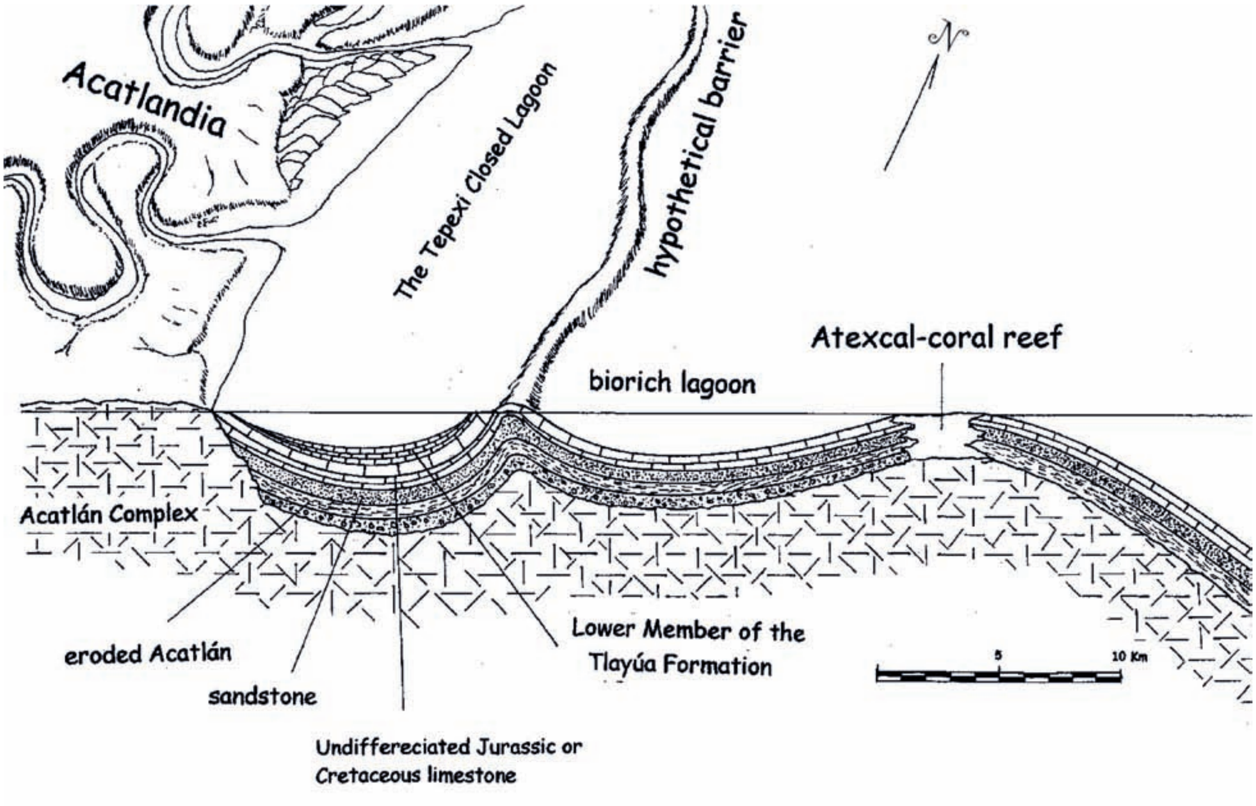

Figure 6. The "shallow water back-reef lagoon". Paleoenvironmental model of Tlayúa (after Applegate *et al*., 2006).

Additionally, some fishes from Tlayúa show affinities with recent taxa that today inhabit brackish and freshwater environments, some of these fishes preserved their gut contents in which freshwater insects and fern fragments have been identify (González-Rodríguez & Martínez-Hernández, 1998).

Evidently, these models (A and B) call for a shallow-small basin, interpretation which in part is based on the discovery of desiccation structures as can be "mud cracks" (see Applegate *et al.*, 2006), depicting episodes in which the lagoon reached sub aerial exposures. Also, the presence of cyanobacterial mats at several layers of the Tlayúa (Middle Member) section suggests that the bottom of the basin was no more than 60 m deep, as has been observed in clear subtropical waters where cyanobacteria can still photosynthesize.

The third model (C) considers the Tlayúa Quarry as an open marine basin with storm-dominated sedimentation and bottom waters with restricted circulation. In variance with the shallow water, back reef lagoonal models, for Kashiyama *et al.* (2004), the Tlayúa beds should be interpreted as a deep basin (near 200 m deep), with a restricted circulation that originated the dis-aerobic or anoxic conditions, that promoted the exceptional fossil preservation.

In their study, Kashiyama *et al.* (2004) also found a repetitive pattern in the sedimentary sequence that was interpreted as Milankovitch cycles, attributed to double monsoon influences from both the northern and southern hemispheres. This information seems to agree with the shallow water back-reef lagoonal interpretations (models A and B) that call for storms or hurricanes that breached the barrier, inundating the Tlayúa basin and transporting the allochthonus biota found in the deposit (Applegate, 1992).

Although the open marine basin model (C) discards tidal deposits (Kashiyama *et al.*, 2004), some of the characteristics of the shallow water deposit models (A, B) are acknowledged, for example, by the presence of terrestrial and marine assemblages. Also, within the open marine interpretation, the lack of any trace of shallow water deposit features is emphasized (i.e. cyanobacterial mats and desiccation cracks), elements that are still controversial (for a better understanding on this topic see Kashiyama *et al.,* 2004 and Applegate *et al*., 2006).

THE FISH FAUNA OF TLAYÚA

On the case of the Chondrichthyes

Pantoja-Alor (1992) and Maisey (2000) reported the presence of hybodontid and heterodontids in Tlayúa, but revisions of the specimens originally interpreted as chondrichthyans do not support such assignments. Actually, no sharks have been found in Tlayúa up to now.

Osteichthyes

The fossil assemblage of Tlayúa involves a single sarcopterygian specimen and a large amount of actinopterygians that can be located within 49 taxa. Their presentation does not imply a phylogenetic sequence.

Sarcopterygii

Axelrodichthys cf. *A. araripensis* (Espinosa-Arrubarrena *et al*., 1996)

Actinopterygii

Amiiformes

Pachyamia mexicana Grande & Bemis, 1998 (Figure 7). This species includes the specimens previously reported as *Vidalamia* by Applegate *et al.* (1984) and Applegate (1996).

Caturid-like [Applegate *et al*. (1984) reported the presence of two or more caturids in Tlayúa but some of these where described as *Michin sernai*]

Amblysemius-like (Figure 7)

Ionoscopiformes

Teoichthys kallistos Applegate, 1988 (Figure 8)
Quetzalichthys perrilliatae Alvarado-Ortega & Espinosa-Arrubarrena, 2008
Ophiopsis-like

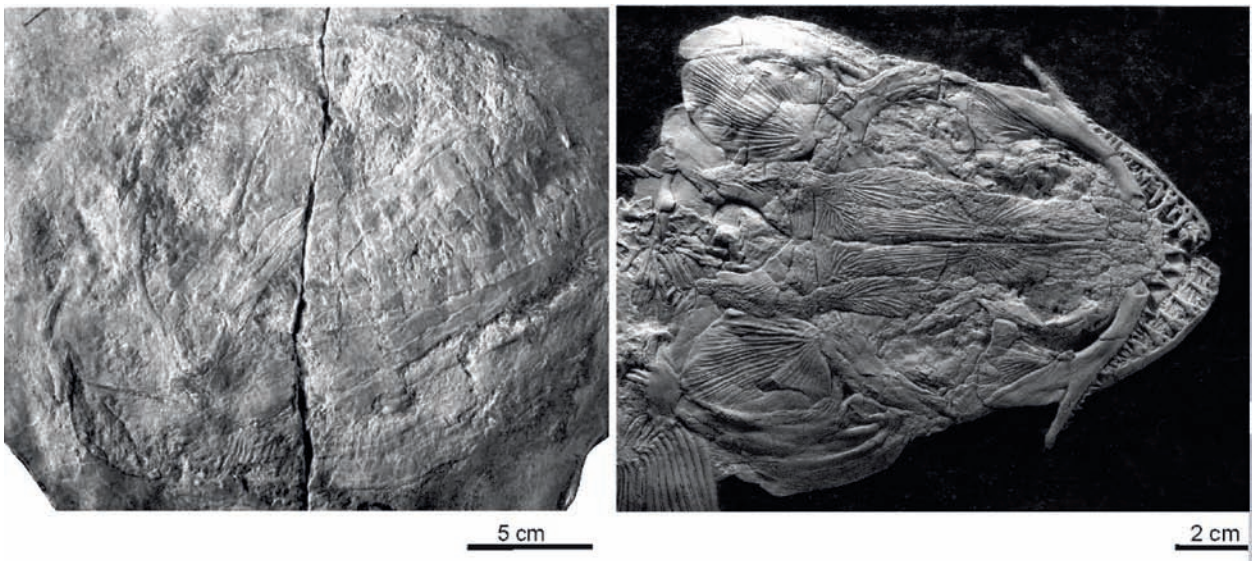

Figure 7. Amiiformes of Tlayúa Quarry. *Amblysemius*-like (left) and *Pachyamia mexicana* (right).

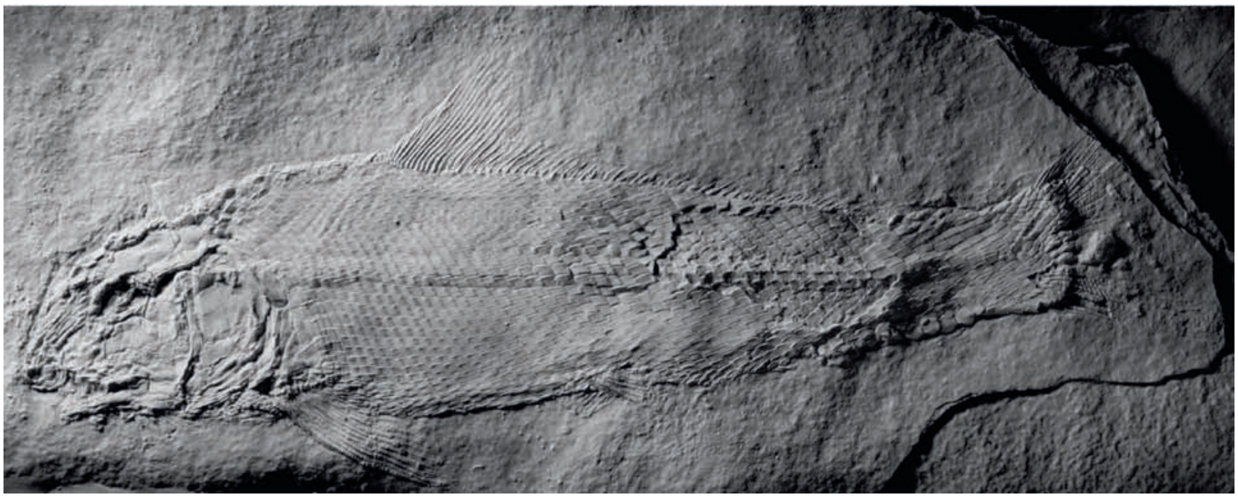

Figure 8. *Teoichthys kallistos*, an ionoscopiform fish of Tlayúa Quarry.

Macrosemiiformes

Since her Bachelor´s degree, our colleague Katy A. González-Rodríguez (1986, 1996, 2004) has been working on this diverse group of fishes found in Tlayúa. So far she has identified the following species:

Macrosemiocotzus americanus González-Rodríguez, Applegate & Espinosa-Arrubarrena, 2004.
Notagogus novomundi González-Rodríguez & Reynoso, 2004
Genus A sp. A [González-Rodríguez (2004:67-77)]
Genus A sp. B [González-Rodríguez (2004:77-94)]
Genus B sp. A [González-Rodríguez (2004:49-64)]

Pycnodontiformes

Tepexichthys aranguthyorum Applegate, 1992 (Figure 9)
Neoproscinetes sp. (Applegate, 2001) (Figure 9)

Although Applegate (2001) gave name to 7 new taxa (genera and / or species), their formal description was being prepared in 2005 when this author sadly died. Currently this work has been taken up by L. Machado and J. Alvarado-Ortega.

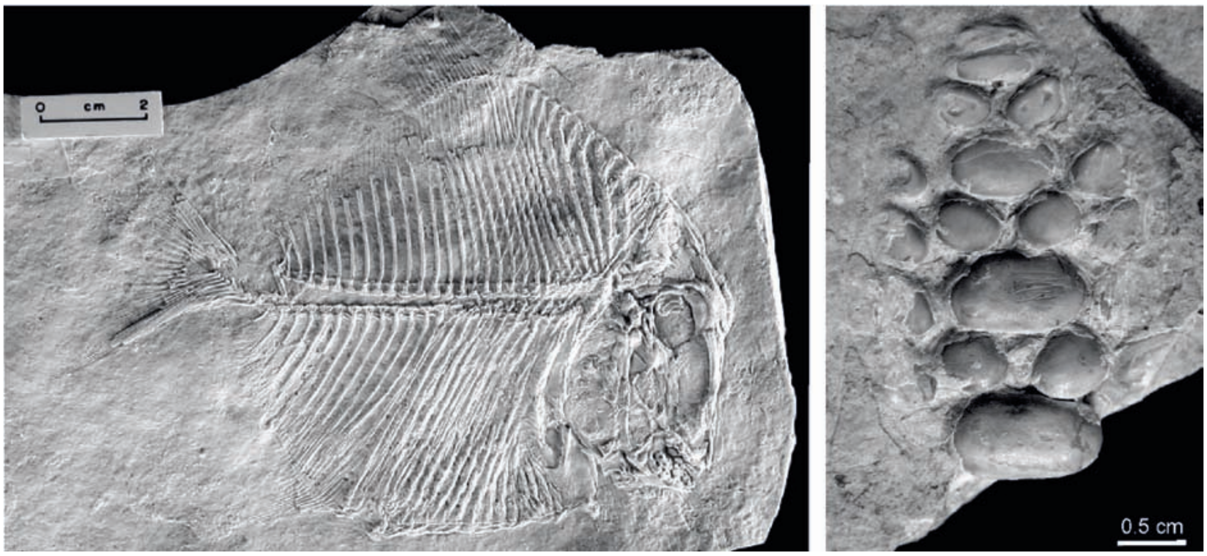

Figure 9. Pycnodontiformes of Tlayúa Quarry. *Tepexichthys aranguthyorum* (left), *Neoproscinetes* sp. (right).

Semionotiformes

Genus and species new López-Arbarello & Alvarado-Ortega, in prep. (Figure 10). (reported first as *Lepidotes* sp. by Applegate (1996), Applegate *et al.* (2000), and Alvarado-Ortega *et al*. (2006).

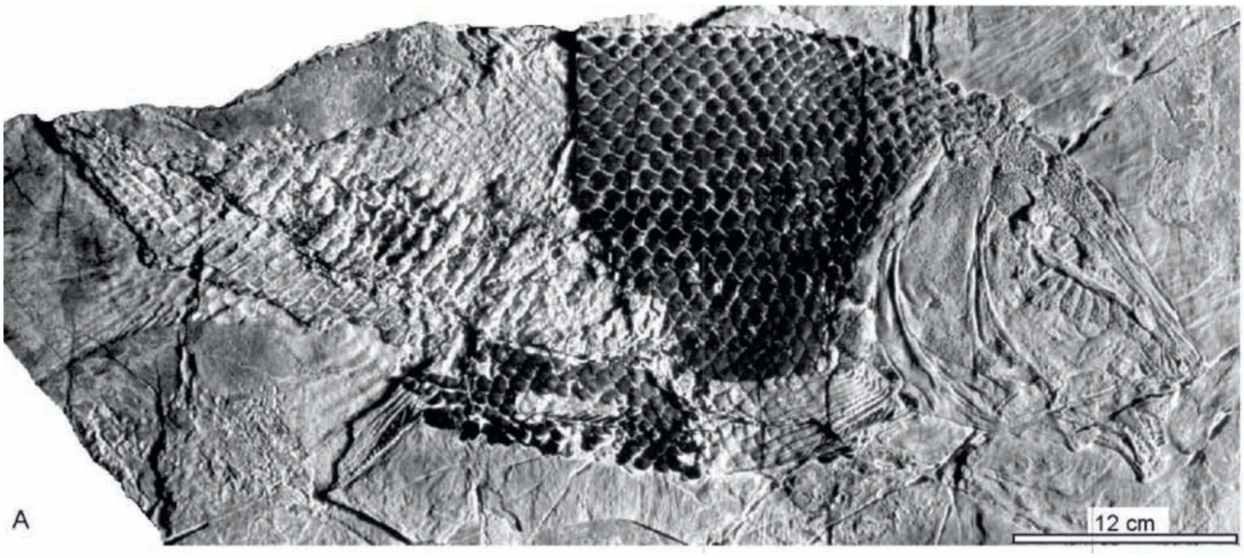

Figure 10. Semionotiform fish from the Tlayúa Quarry.

Aspidorhynchiformes

Aspidorhynchiforms are currently under study by Paulo M. Brito and Jesús Alvarado-Ortega. So far only three different species have been recognized.

Belonostomus sp. A.
Belonostomus sp. B.
Vinctifer sp.

“Pholidophoriformes”

“Pholidophorid”-like.

Ichthyodectiformes

This group was reported as chirocentrids by Applegate *et al*. (1984), as *Cladocyclus* by Applegate (1999) and Maisey (2000). Since 1998 J. Alvarado-Ortega has been on charge of the study of these fishes and so far he identified five forms. In general terms, in Tlayúa there are primitive forms (pectoral fin is in the middle of the body) with about 64 total vertebrae (as in *Cladocyclus*) but unusually it coexists with forms having about 80 (as in *Unamichthys*) or about 50 total vertebrae (as in *Chiromystus*). This assemblage is unique among Cretaceous localities bearing ichthyodectiforms (Alvarado-Ortega, 2005).

Unamichthys espinosai Alvarado-Ortega, 2004 (Figure 11)
Form A a (Figure 11)

Form A b
Form B a
Form C a

Osteoglossomorpha

Lycoptera-like (Niels Bonde is studying three small specimens that resemble the shape of *Lycoptera*).

Undescribed form.

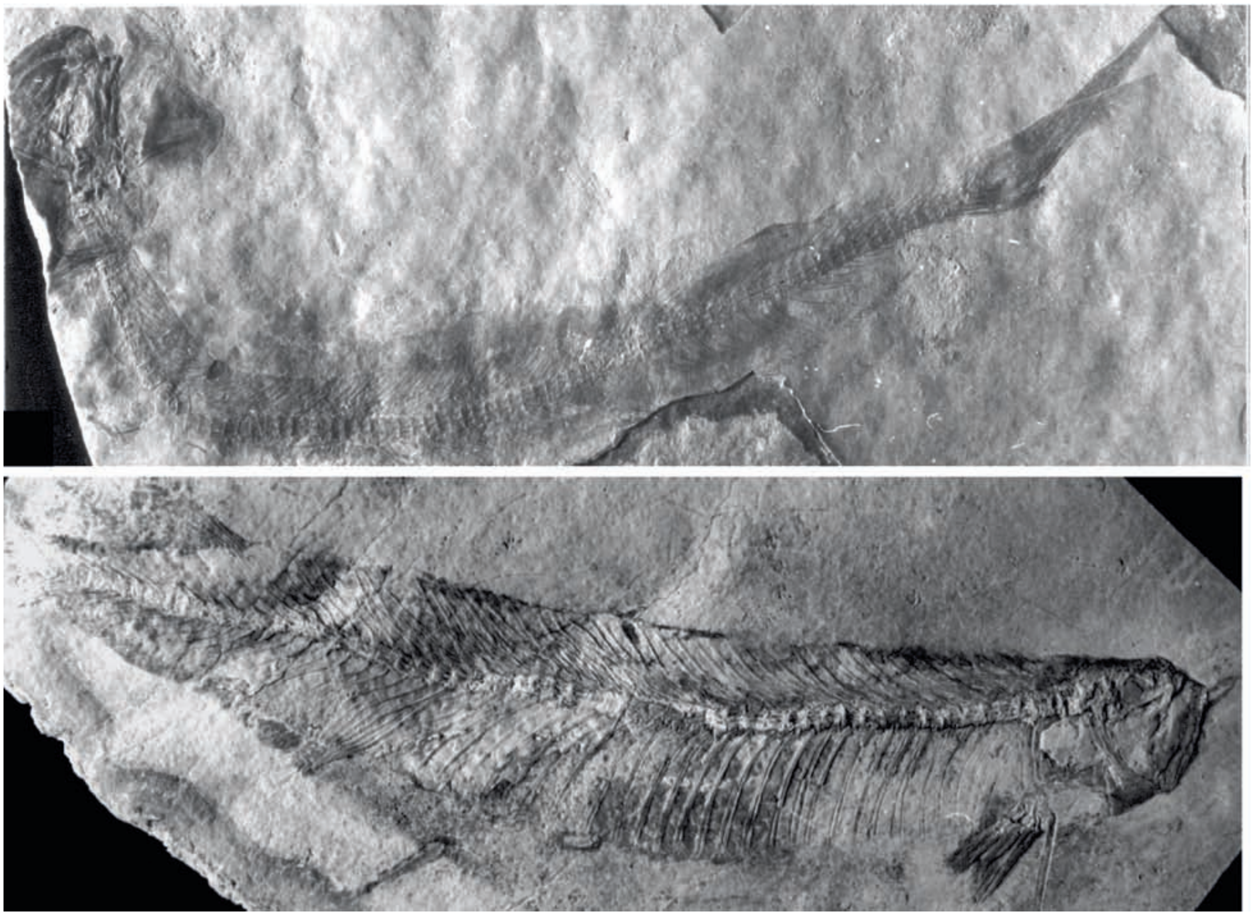

Figure 11. Ichthyodectiformes of Tlayúa Quarry. *Unamichthys espinosai* (top) and a 50 total vertebrae fish (form A a) (bottom).

Elopocephala *incertae sedis*: Araripichthydae

Araripichthys sp.

Elopiformes

Brannerion-like (Figure 12)
Megalops-like.
Paraelops-like.

Tselfatiiformes

Bananogmius-like

Crossognathiformes

Michin scernai Alvarado-Ortega, Mairinck & Brito, 2008 [This fish was previously reported as *Rhacolepis* by Applegate (1996) and Maisey (2000)].
Notelops sp. [in Maisey (2000)]
Rhacolepis-like (this fish resembles *Michin* but its scales are larger)

Figure 12. *Brannerion*-like fish from Tlayúa Quarry.

Ellimmichthyiformes and other basal clupeomorphs

Applegate *et al*. (1984:68) recorded the possible occurrence of *Clupea* and *Syllaemus* in Tlayúa and later Chang & Grande (1997, fig. 7) reported *Ellimmichthys* sp. Currently, clupeomorphs from the Tlayúa Quarry are under study by María del Pilar Melgarejo-Damián. So far, at least four species belonging to basal clupeomorphs have been identified in Tlayúa.

Undescribed basal clupeomorph (Figure 13)
Armigatus sp.

Ellimmichthys sp. A (Figure 14)
Ellimmichthys sp. B.

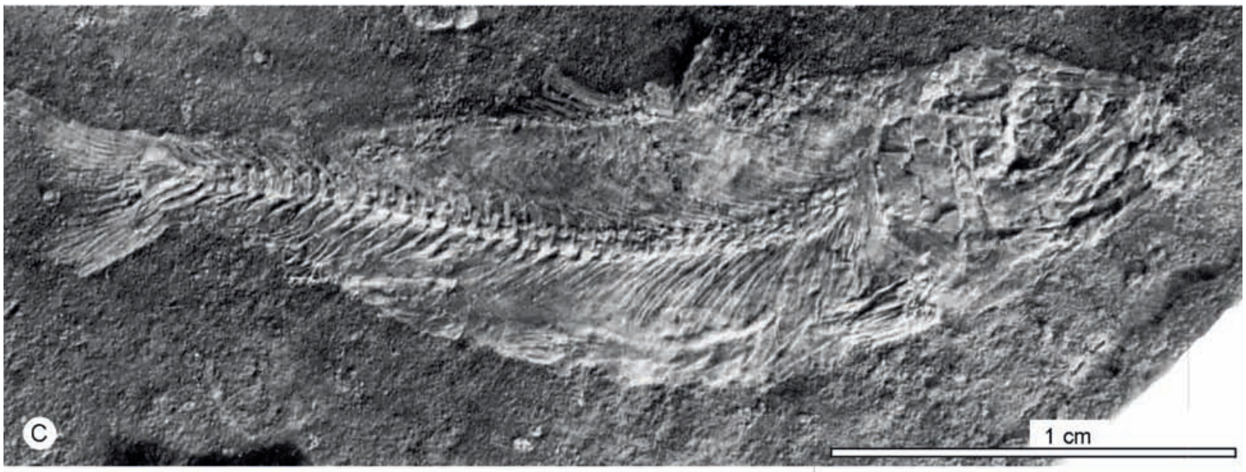

Figure 13. An undescribed clupeomorph fish from Tlayúa Quarry.

Figure 14. *Ellimmichthys* sp. A. from Tlayúa Quarry.

Gonorynchiformes

Undescribed form A (reported by Applegate, 1996) (Figure 15)
Undescribed form B

Aulopiformes

Undescribed enchodontid (Figure 15)

Yabrudichthys-like (According to Applegate, 1996)

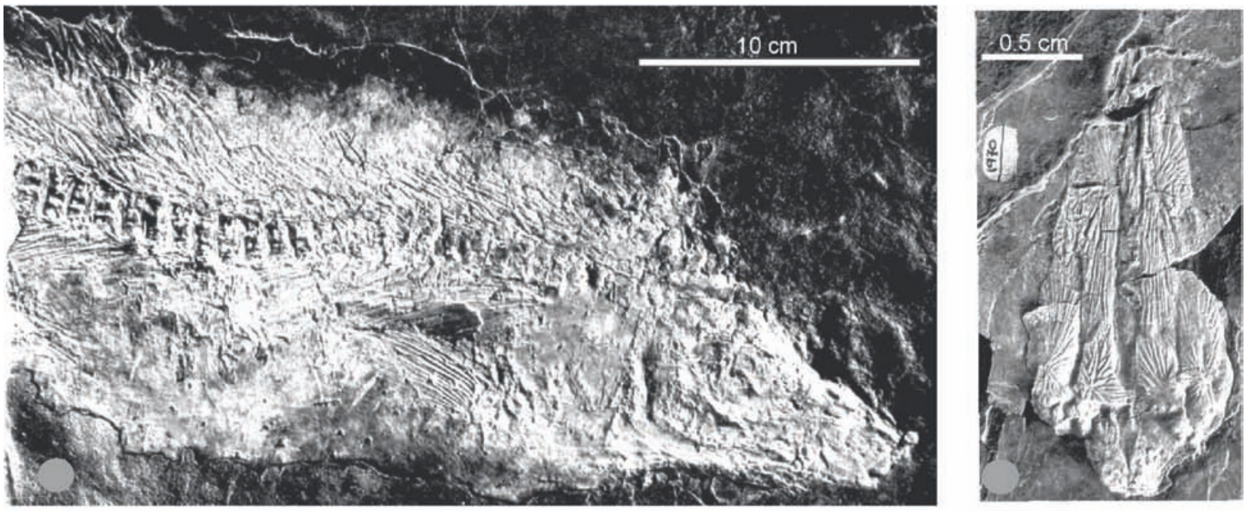

Figure15. Gonorynchiform fish reported by Applegate (1996) (left), and an enchodontid skull recovered in Tlayúa (right).

Beryciformes

At least one undescribed beryciform was identified by Applegate (1996).

FINAL REMARKS

An exciting future is waiting for the small Mexican paleoichthyological group, who are facing the challenge to study a comparatively large Mesozoic fish record found in this country. Tlayúa represented the best excuse for the emergence of the first generation of Mexican paleoichthyologists headed at first by our teacher and friend Shelton P. Applegate. Although the amount of fossil fishes found in Tlayúa is comparatively large, it represents only the tip of the iceberg of the potential that México fossil fish record has. With all probabilities, the incoming studies on Mexican fossil fishes are going to change our current understanding of the evolutionary and biogeographic processes of several Mesozoic fish groups.

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FIELD TRIP TO SOME UPPER CRETACEOUS PALEONTOLOGICAL LOCALITIES IN COAHUILA STATE

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The Difunta Group in the Parras Basin of southern Coahuila (Figure 1), México, has a maximum thickness of 4,000 m and consists of interbedded terrestrial and shallow, open marine strata that filled the basin from the south and west. In the study area, the Difunta Group has been divided into seven formations reflecting these interbedded facies. In ascending order these are: the Cerro del Pueblo, Cerro Huerta, Cañón del Tule, Las Imágenes, Cerro Grande, Las Encinas, and Rancho Nuevo. An extensive terrestrial fauna is known from the Cerro del Pueblo and basal Cerro Huerta Formations.

The Cerro del Pueblo Formation is divided into a lower cliff-forming sandstone and a thick, slope- and ridge-forming interval of interbedded freshwater, brackish, and marine facies interpreted to represent the effect of delta lobe switching on a delta plain. Although dinosaur remains are present in the overlying red beds of the Cerro Huerta Formation, most dinosaur research in the Difunta Group has been directed at the upper unit of the Cerro del Pueblo Formation, where dinosaurs occur in all facies. The abundance of dinosaur skeletons in brackish water and marine facies is unique among known dinosaur occurrences and suggests that dinosaurs were not simply washed in, but represent animals traversing what must have been extremely shallow marine environments.

Paleomagnetic studies indicate that the Cerro del Pueblo Formation in the Saltillo area was deposited during magnetozones 32n.3r-32n.2n. Correlation of this range within the combined Western Interior ammonite biozones B. reesidei to B. jenseni indicates a maximum absolute age of 72.5 Ma, and thus is Late Campanian in age. Dinosaur localities of the Cerro del Pueblo Formation are the southernmost representation of the well-studied late Campanian terrestrial faunas on the western side of the North American Cretaceous Western Interior Seaway, and represents a unique climatic setting south of peat-rich coastal habitats characteristic of the United States and Canada.

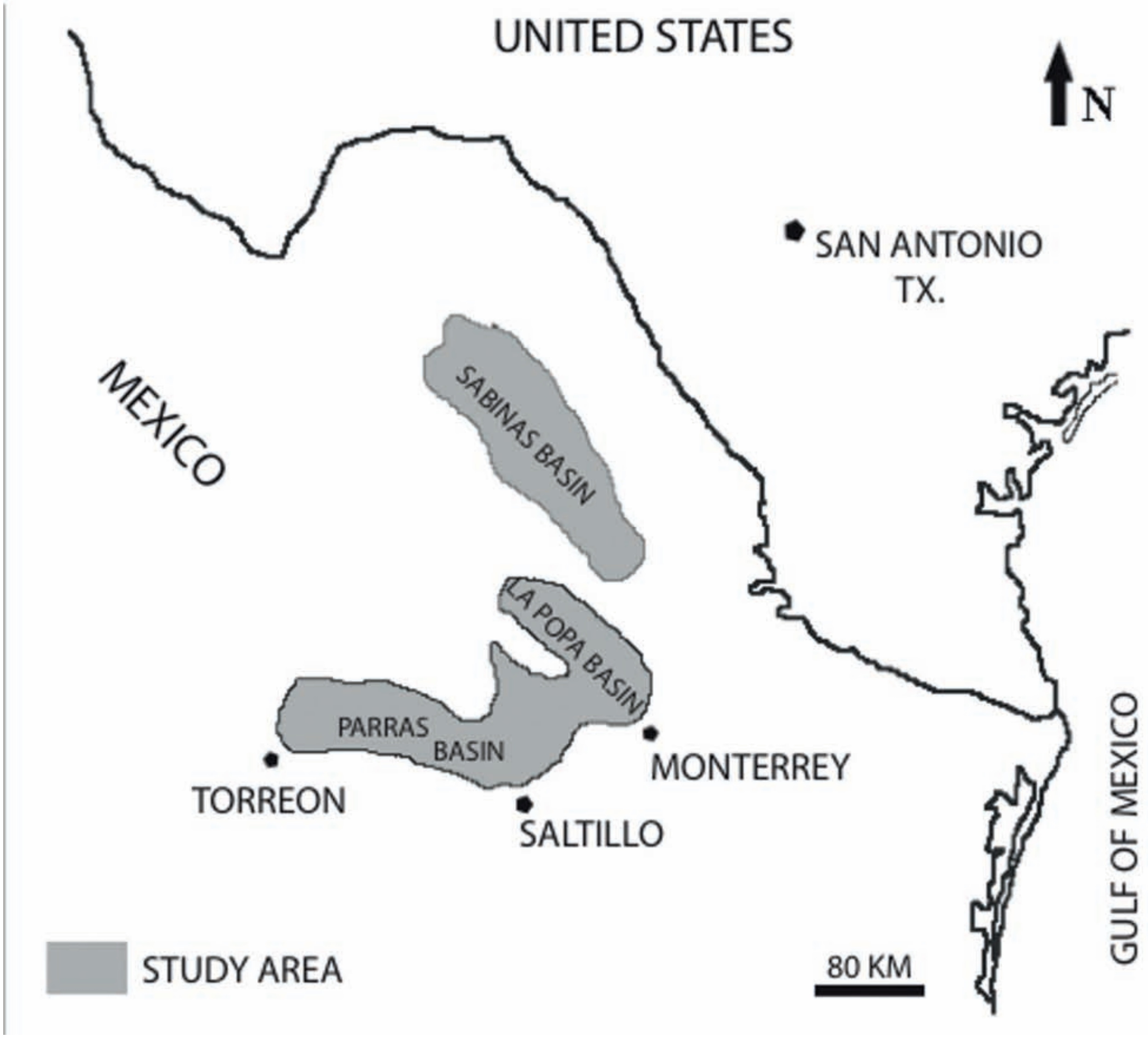

Figure 1. Location of the Parras Basin in the Coahuila region.

Itinerary

(See Figure 2)

August 7

8:00 Departure from Hotel Quinta Dorada

8:15 Stop to see a section of the Parras Basin Formation, southern Coahuila, where the Upper Cretaceous Difunta Group is exposed and specimens of Ischirhiza mira and Squalicorax kaupi have been found.

9:00 Arrival to the Museo Paleontológico “Ejido Rincón Colorado”, Coahuila.

Small museum that shows the diversity of fossils found in the area which is now well known, mostly due to its dinosaurs

9:05-11:00	Visit to the museum and the quarries at Rincón Colorado where the dinosaur Velafrons coahuilensis was found. First Lambeosaurine (hadrosaur) named for México and the most complete. This locality is known for producing rostral material of Schizorhiza with teeth in place.
11:00	Departure to Porvenir de Jalpa where you will see some dinosaur tracks
12:00-12:45	Lunch at the locality
12:45-13:30	Visit to the ichnological locality known as “Porvenir de Jalpa”. The largest assemblage of dinosaur trackways known from México, a large area crisscrossed with the tracks of different kinds of dinosaurs. At the present, three ichnotaxa have been recognized. This site is late Campanian in age.
13.30-15:30	Stop at Coahuilaceratops quarry, to do some prospecting. Here you can see freshwater deposits where holostean indet, amiiform and lepisosteid fish, have been recovered.
15:30	Departure to the town of General Cepeda, where the major will offer a farewell dinner. On the way there, we will have a brief stop in an archaeological site called “Narihua”, to see some petroglyphs
16:30	Arrival to General Cepeda
16:30-18:30	Party time
19:00	Departure from General Cepeda to the hotel
20:30	Arrival to the hotel in Saltillo, Coahuila

End of Field Trip.

Note: All the times calculated for this itinerary are approximated and will be adjusted according to the local conditions.

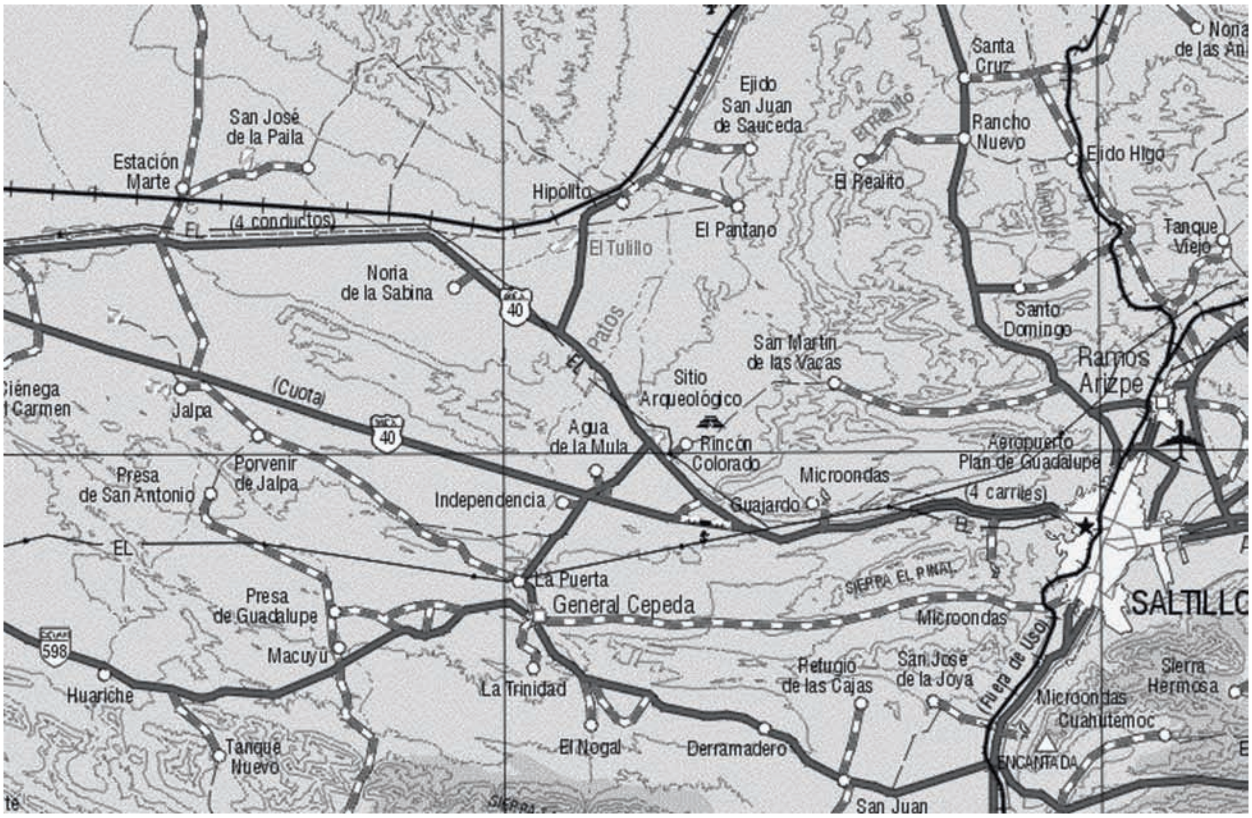

Figure 2. Location of some paleontological sites we will visit around Saltillo, Coahuila.

THE TURONIAN PLATY LIMESTONE AT VALLECILLO, NUEVO LEÓN, MÉXICO, AND ITS FISHES

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The Vallecillo Platy Limestone

Vallecillo is located 100 km to the north of Monterrey in the northeastern Mexican state of Nuevo León (Figure 1).

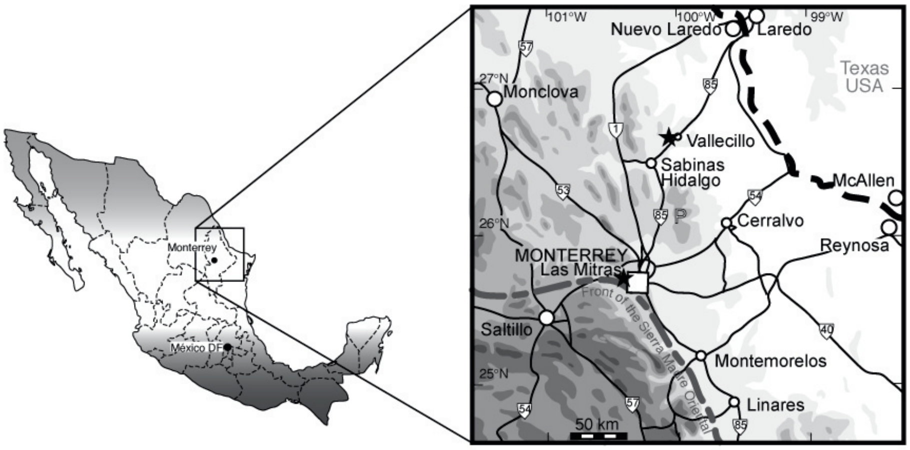

Figure 1. Map of México with detail of northeastern México. Vallecillo, marked by an asterisk, is located at the Mexican highway 85 which connects Monterrey with Laredo, Texas

The Vallecillo Platy Limestone was discovered during the construction of the highway 85 in the 1960s. Since then several small quarries were opened along a dirt road of 1 km length branching off the main road to the West (Figure 2). Until today, extraction and preparation of the slabs is entirely manual. Large iron bars are used to extract suitable blocks, which are then split with axe, chisel and hammer to thicknesses between 2 and 5 cm, with the shape and size of the resulting slabs left casual. About three quarters of the rocks extracted in the Vallecillo quarries is suitable as flagstones and tiles for floors and walls.

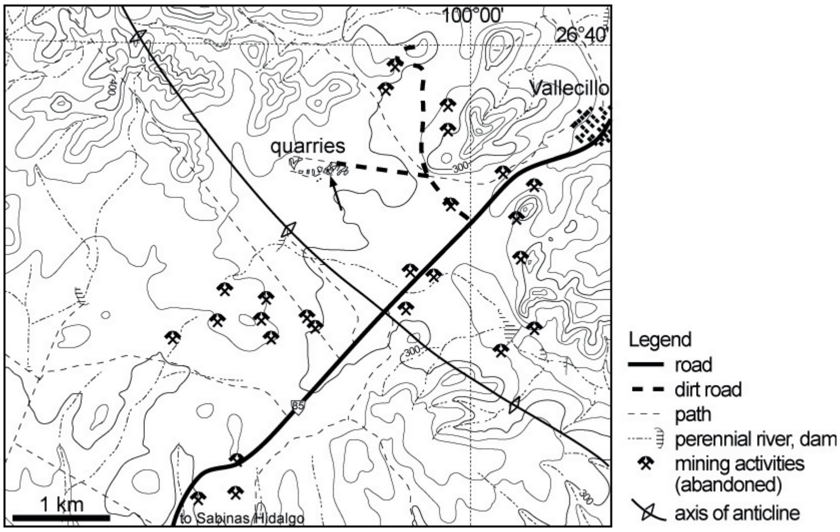

Figure 2. Map of the vicinity of Vallecillo. The largest of the quarries is situated at 26°39'19"N, 100°00'49"W and marked by an arrow.

Fossils are found throughout the Platy Limestone. Rocks less than ~1 m from the surface are altered by pedogenesis. Although this enhances the fissility of the rock, the fossils in these layers are heavily weathered and poorly preserved.

Age

The Platy Limestone is part of the Vallecillo Member, which forms a distinct unit of the Agua Nueva Formation, a monotonous series of limestone and marl that formed in the outer shelf environment of the ancient western Gulf of México (Figure 3) with a wide regional occurrence.

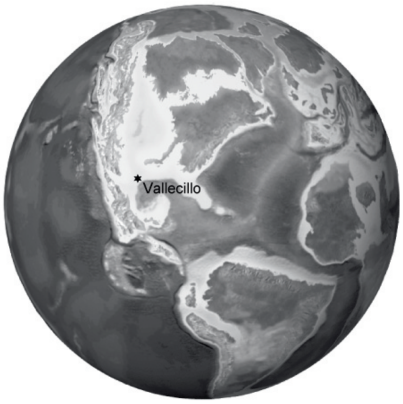

Figure 3. Palaeogeographic map of North America with position of Vallecillo marked by an asterisk.

The invertebrate fossils and planktic foraminifers indicate a latest Cenomanian to early Turonian age of the Vallecillo section and allow for a detailed biostratigraphic subdivision (Figure 4).

The mollusk taxa represent a mixture of Western Interior and Tethyan elements, owing to the paleogeographic position of the Vallecillo sea at the junction of the Western Interior Seaway and the expanding Atlantic Ocean (Figure 3). The Paleogulf of México is thus considered to be part of both the Western Tethyan and the North American molluskan faunal provinces (Ifrim, 2006; Ifrim & Stinnesbeck, 2007, 2008). The well-studied bio- and lithostratigraphy also allowed for the reconstruction of the layer of origin of two mosasauroids (Ifrim *et al*., 2008a) and of shark teeth (Stinnesbeck *et al*., 2007).

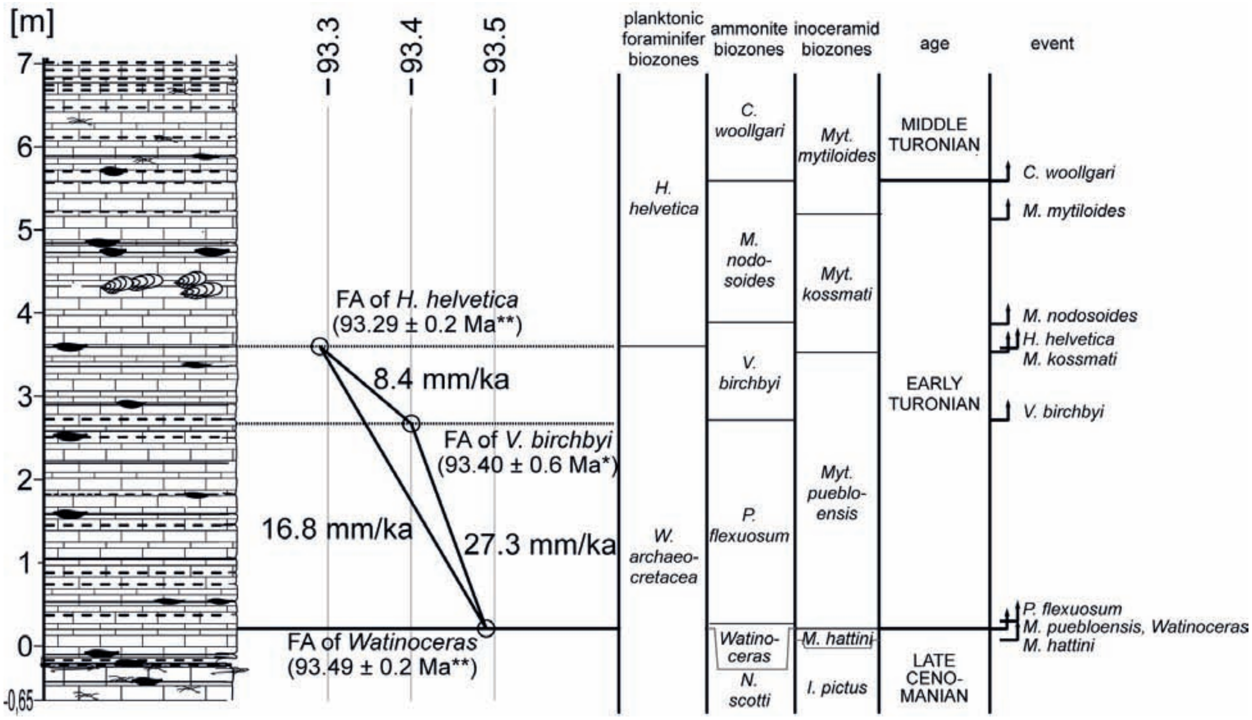

Figure 4. The Vallecillo section is about 8 m thick, with the typical platy limestone lithology exposed from level 0.05 m to approximately 5.5m. Upsection, the lithology and preservation of fossils change slightly. The upper end of the section corresponds approximately to the upper end of the Platy Limestone member. The age-depth plot of the Vallecillo section gives an approximate idea about sedimentation rates. For details see Ifrim (2006). A late Cenomanian age of the lowermost 0.84 m of the Vallecillo section is indicated by the presence of *Inoceramus pictus*. No ammonoids were recovered from this interval, which correlates to the uppermost Cenomanian *Nigericeras scotti* zone (Ifrim & Stinnesbeck, 2007). The first appearances (FAs) of *Watinoceras coloradoense* and *Mytiloides puebloensis* at 0.84 m above the base of the section indicate the base of the Turonian stage (Ifrim & Stinnesbeck, 2008). Up-section, the FAs of *Vascoceras birchbyi*, *Mytiloides kossmati* and *Mammites nodosoides* allow for further subdivision of the lower Turonian.

Preservation

When the limestone is cleaved, the fossils are usually split between slab and counterslab. Although Vallecillo fossil vertebrates are preserved flattened, most bones remain uncrushed. The skeletons of large (> 1 m) vertebrates are compressed into single bedding planes, but most bones are preserved three-dimensionally or show impaction breaks. Bone material and intestinal contents are preserved as dark gray calcite. The perfect cleavage of the coarse (ca. 1 mm) calcite crystals in one direction is the reason, why fossils usually cleave easier than the matrix, where microcrystalline components are interlocked (Ifrim *et al*., 2005b). Fish scales, isolated gills and soft parts are preserved as imprints, with only lepidotrichians being mineralized.

Vertebrate assemblage

Fish remains are the most abundant fossils found at Vallecillo, comprising more than half of the excavated assemblage (Figure 5). Other fossil groups present at Vallecillo are inoceramid bivalves and ammonites, as well as rare other body fossils like e.g., drift-wood, coprolites and pellets.

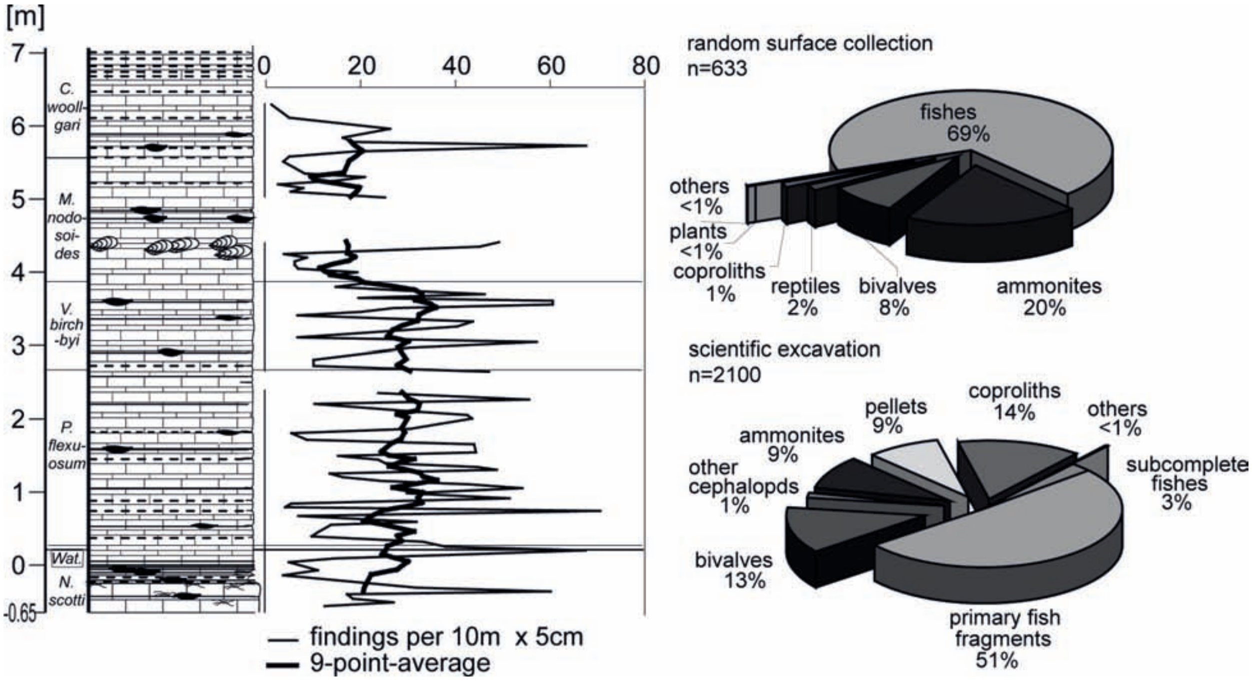

Figure 5. Left: distribution of fossils over the Vallecillo section. Right: Comparison of abundances of fossil types in the random collection (upper) and scientific excavation (lower) shows severe differences regarding their shares. This points to a strong filtering of fossils in the random collection by preferential collection of certain large fishes, ammonites, and other taxa.

The fossil assemblage at Vallecillo is composed of nektonic animals, with the exception of inoceramid bivalves. To date, 14 taxa of elasmobranches, teleosteans, and sarcopterygians were identified. Most of the specimens are housed in the collection of the UANL-FCT. Some taxa such as *Araripichthys* sp. indet., *Goulmimichthys roberti*, *Rhynchodercetis regio*, '*Robertichthys riograndensis*', and *Vallecillichthys multivertebratum* were described in detail (Blanco *et* *al*., 2001; Blanco-Piñon *et al*., 2002; Blanco & Cavin; 2003; Blanco-Piñon, 2003; Blanco-Piñon & Alvarado-Ortega, 2005; Blanco-Piñon *et al*., 2005; Blanco & Alvarado-Ortega, 2006; Blanco-Piñon *et al*., 2007). Other taxa are currently under preparation and investigation. The presentation below does not follow a phylogenetic sequence.

Chondrichthyes

Lamniformes

Lamniformes indet.
(Figure 6)

Remains of lamniform sharks were described from Vallecillo by Blanco-Piñon *et al*. (2005). They all lack teeth or the outline of the preserved soft parts, this would allow a more precise determination. The remains (e.g. in Figure 6) belong to individuals with a reconstructed total length from 1 m to 3 m.

Figure 6. Articulated lamniform vertebrae (UANL-FCT-VC/829). Scale = 5 cm.

Ptychodus decurrens Agassiz, 1835
(Figure 7)

This ptychodontid shark is known by disarticulated dentitions with additional softparts. The tooth crowns of median teeth show 6 to 8 parallel orientated strong transversal ridges, perpendicular to crown margins. These ridges branch into finer, anastomosing lines that end in a radially wrinkled area at the crown margin. Lateral central crown tapers gradually to crown margins. Anterior edge of crown rounded, posterior edge smoothly indented. Habitus and surface-ornamentation match the teeth of *P. decurrens* known from Aptian to Turonian deposits from Europe, Africa and Northern America.

Figure 7. Part of the disarticulated dentition of *Ptychodus decurrens* (CPC-427) showing teeth in occlusal and labial views. Scale = 10 mm.

Ptychodus mortoni is also known from the Vallecillo area (Blanco-Piñon *et al.,* 2007), but not from the Platy Limestone (Stinnesbeck *et al*., 2007).

Osteichthyes

Pachycormiformes

Pachycormidae indet. (Figure 8)

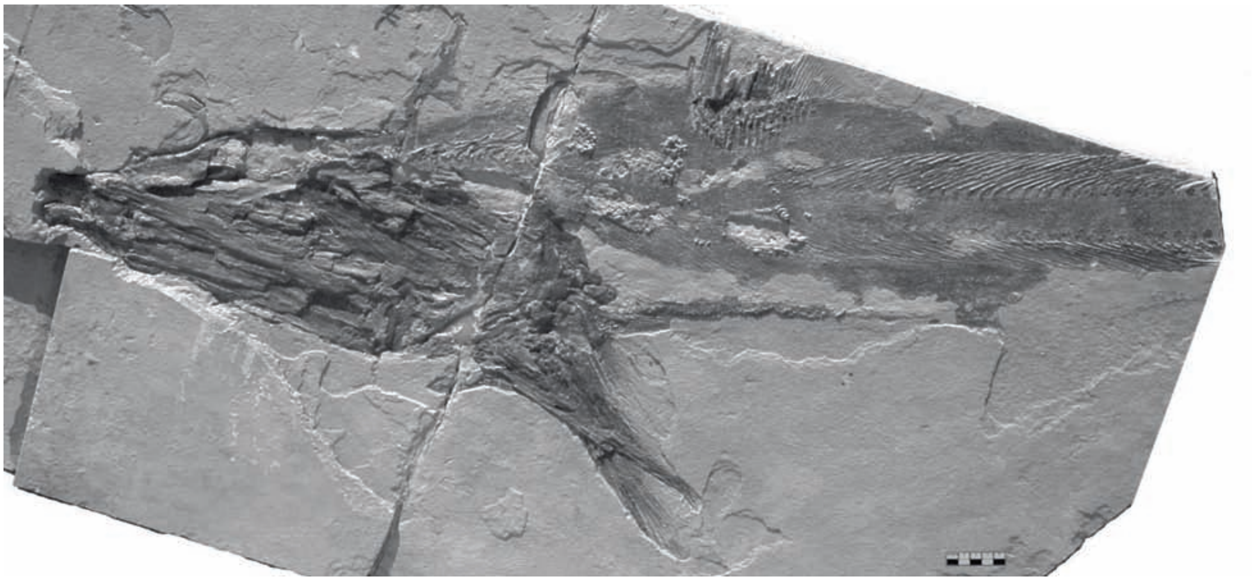

Figure 8. The only known pachycormiform from Vallecillo (UANL-FCT-VC/87). Scale = 5 cm.

Pycnodontiformes

Nursallia gutturosum

This pycnodontid species from Vallecillo is the third most abundant fish in the locality. The total length of *Nursallia* specimens from this locality is 2.5 to 40 cm. The high abundance and the occurrence of different ontogenetic stages indicate that *Nursallia* was a true autochtonous element of the Turonian ichthyofauna from Vallecillo.

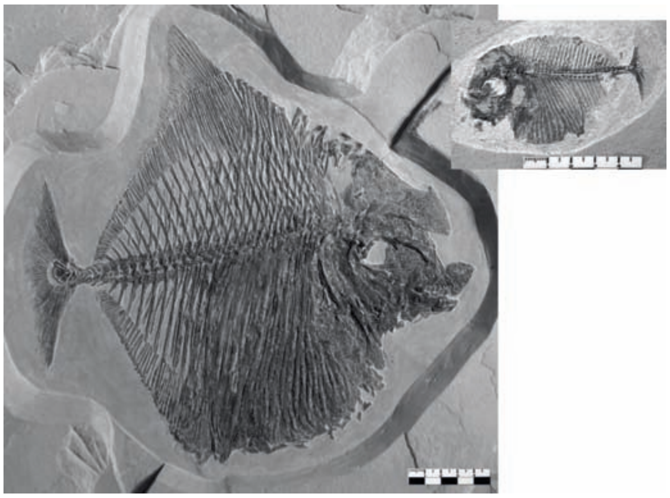

Figure 9. *Nursallia gutturosum*. Left: this specimen lacks only the ventral fin (CPC-302). Right: A juvenile, slightly disarticulated *Nursallia gutturosum* (CPC-428). Scale = 5 cm.

Aspidorhynchiformes

Belonostomus sp.

The Platy Limestone from Vallecillo comprises articulated and almost complete specimens of this aspidorhynchid fish that shows known characters of *Belonostomus sp.* Length of mandible equals rostrum; predentary captures 65 % of mandible length and shows an ellipsoidal cross section; suture between dentosplenial and predentary formed by an antero-ventral inclined plane area. Principal flank scale is about three times higher than the dorsal and ventral following (Figure 10).

Figure 10. Articulated specimen of *Belonostomus* sp. (CPC-303). Scale = 5 cm.

Crossognathiformes

Goulmimichthys roberti (Blanco & Cavin, 2003)

The smallest pachyrhizodontid from Vallecillo seems to be the most abundant (Figure 11).

Figure 11. *Goulmimichthys roberti*. Above: incomplete, partially disarticulated specimen (CPC-430). Below: articulated specimen. Scale same as above.

Most of the specimens remained unprepared, so the occurrence of juvenile individuals of other pachyrhizodontids within the suggested *Goulmimichthys* material cannot be excluded for the moment.

Pachyrhizodus caninus Cope, 1872 (Figure 12)

This largest species within the genus is represented by a single specimen of disarticulated skull remains (Figure 12). The dimensions of the bones, the pleurodont dentition and two inner teeth on the premaxillary place the specimen in *P. caninus*, among other details (Giersch *et al*., in press). The dimension of the bones indicates their affiliation to an individual of ca. 2 m in total length. *P. caninus* is a typical faunal element of the Upper Cretaceous Western Interior Seaway of Northern America. However, *P. caninus* seems to have been an infrequent inhabitant of the Vallecillo Sea.

Figure 12. Left: Disarticulated skull bones of *Pachyrhizodus caninus* (CPC-301). Scale = 10 cm. Right: Zoom on the premaxilla, ventral view.

Pachyrhizodus sp.

At least a third, medium sized pachyrhizodontid species occurs in the locality. Incomplete and unprepared material impedes better determination. One unprepared specimen shows a premaxilla wearing one prominent inner tooth, perhaps suggesting a relationship with *P. leptopsis.*

Tselfatiiformes

Tselfatia formosa Arambourg, 1954

This fish shows all characters of *Tselfatia formosa* (Figure 13), which was first described from Djebel Tselfat in Morocco. It shows for example an ossified interorbital septum, medially meeting parietalia, a dorsal fin arising above head, showing a broad first ray, which is armored by pseudo-fulcra. The anal fin shows a similar first ray. The caudal skeleton shows hypurals which are fused to a symmetrical fan-shaped plate supporting a deeply forced caudal fin. The pectoral fin inserts just ventrally to vertebral column. *Tselfatia formosa* is the second most abundant fish in the Vallecillo sea and known from specimens with a total length of 3 cm up to 80 cm.

Figure 13. Tselfatia formosa: incomplete specimen (CPC-429). Scale = 10 cm.

Ichthyodectiformes

Gillicus arcuatus Cope, 1875

Few but well articulated specimens of *Gillicus arcuatus* are known from Vallecillo (Figure 14). Prepared specimens show badly known details like the elongated anal fin. According to Blanco & Alvarado-Ortega (2007), this Character is known from basal ichthyodectids like *Thrissops, Unamichthys, Cladocyclus, Eubiodectes* or *Chirocentrites*. Therefore *Gillicus* has to be excluded from the ichthyodectids sensu Blanco & Alvarado-Ortega (2007) as it is already suggested in their phylogenetic hypothesis. Like *Pachyrhizodus caninus*, *Gillicus arcuatus* is also a well known faunal element from the Western Interior Seaway. Their occurrence in Vallecillo, prove an interchange between the Western Interior Seaway and the Cretaceous Gulf of México within the ichthyofaunas (Giersch *et al*. 2008).

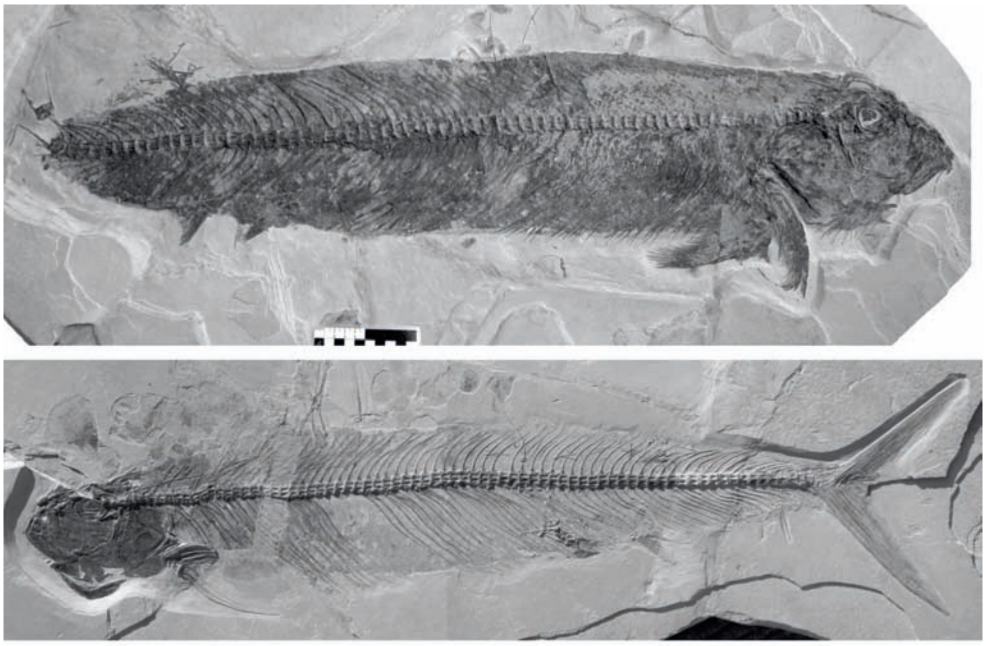

Figure 14. Above: incomplete specimen of *Gillicus arcuatus* (CPC-431). Scale = 10 cm. Below: *Gillicus arcuatus* with a total length of ca. 1.1 m (CPC-432). Vertebral column and caudal fin partially reconstructed.

Vallecillichthys multivertebratum (Blanco & Cavin, 2003)

This ichthyodectiform is characterized by a very elongated body (Figure 15). The total length of the documented specimens ranges from 70 to 110 cm. The vertebral column consists of 98 vertebrae, with 74 abdominal and 24 caudal centra. *Vallecillichthys multivertebratum* is fairly frequent throughout the section. However, it is hitherto known solely from the Vallecillo quarries.

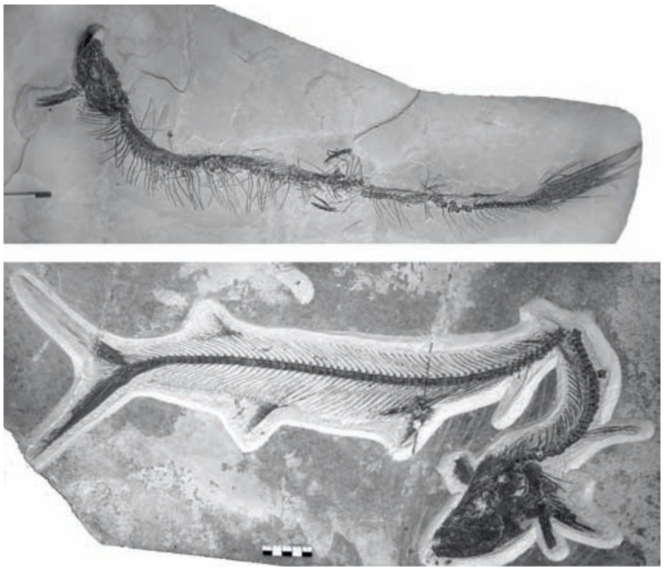

Figure 15. *Vallecillichthys multivertebratum.* Above: incomplete skeleton, total length: 1.10 m (CPC-300). Below: complete specimen (CPC-438). Scale = 5 cm.

Aulopiformes

Rhynchodercetis regio (Blanco & Alvarado-Ortega, 2006**)**

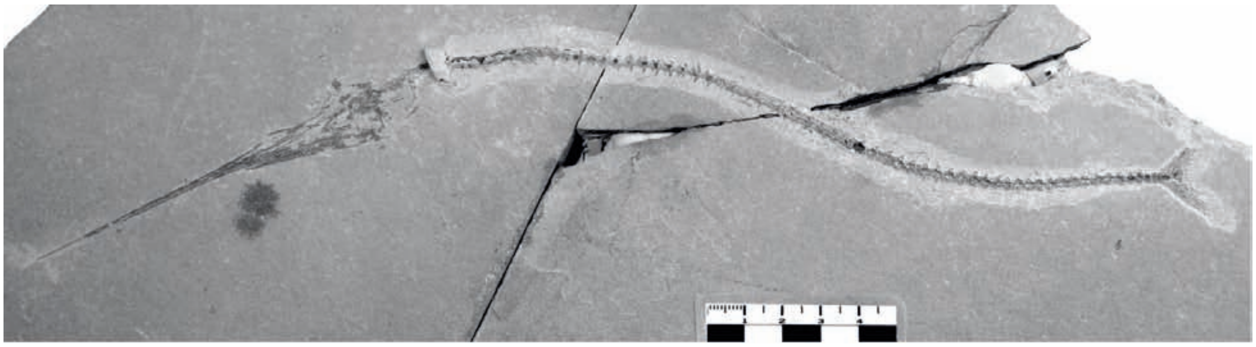

Figure 16. *Rhynchodercetis regio* (CPC-435).

This needlefish is the most abundant fish in the locality and is known by ontogenetic stages from 7 to 40 cm total length. However, complete specimens are rare, owing to its fragile skeleton. Analysis of stomach content indicates that *Rhynchodercetis* was an important food source for predating fishes such as *Vallecillichthys* or *Pachyrhizodus* (Giersch *et al*., 2009)*.*

Araripichthys sp.

A single specimen is hitherto known, unfortunately with crushed skull, shown in Figure 17 (left).

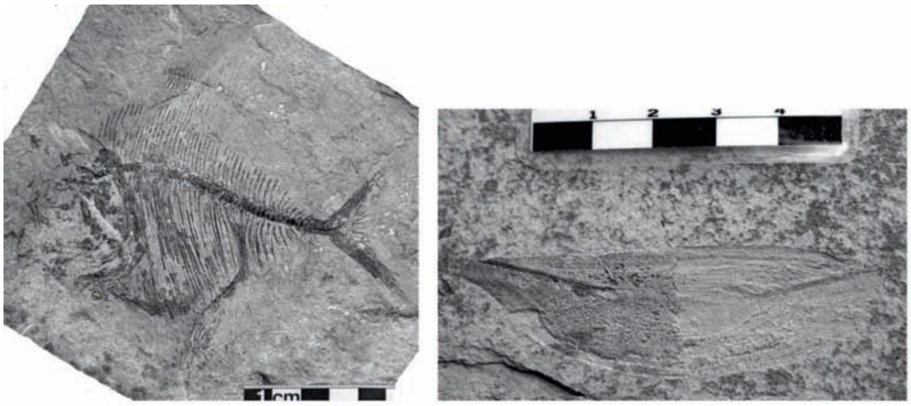

Figure17. Left: The *Araripichthys* sp. specimen from Vallecillo (UANL-FCT-VC/340). Right: Gular plate of a coelacanth (UANL-FCT-VCI ⁄ 150A). Scale = 5 cm.

Latimerioidei Schultze, 1993

Fam., gen. et sp. indet.

A supposed fossil shell vestige of an octopod (Fuchs *et al.,* 2008) shown in Figure 17 (right) turned out to be the remain of a coelacanth (Schultze *et al*., 2010).

Marine Reptiles

Marine reptiles comprise the remains of seven mosasauroid individuals, some of them with intestinal contents and extensive skin preservation, as well as three fossil turtles and the tooth of a pliosaur (Figure 18). The mosasauroids and the pliosaur tooth are preliminarily described and are registered in Mexican collections (Buchy *et al*., 2003, 2005; Ifrim *et al*., 2008a; Smith & Buchy, 2008).

Figure 18. Marine reptiles from Vallecillo. Above: incomplete mosasauroid, lacking only its long tail (CPC-256). Scale = 5 cm. Lower left: incomplete turtle, length = 15 cm (UANL-FCT-R09). Lower right: isolated tooth of a pliosaur. Height = 3 cm (UANL-FCT-R26).

Palaeoenvironment

The absence of benthic biota other than inoceramids makes the estimation of water depths difficult, but was estimated to 100 m or more (Ifrim *et al*., 2008a). This interpretation is consistent with the fine-grained sediment, the absence of current indicators such as oriented fossils or fossils dismembered by drift, the pelagic microfacies and the paleogeographic location of Vallecillo (Figure 3).

A quantitative estimation of sea-surface temperatures cannot be given for Vallecillo, because $\delta^{18}O$ values are altered by meteoric diagenesis (Ifrim, 2006). However, warm surface waters are indicated by the presence of keeled planktonic foraminifers and an arid climate is known to have existed on land to the west and northeast of the Vallecillo sea. The platy limestones are composed of 10% of the clay mineral illite, which supports this interpretation. Furthermore, clay-sized quartz grains of likely aeolian origin may come from adjacent desert plains (Ifrim, 2006). These data suggest that high insolation of the surface waters heated the upper water layers.

The widespread regional distribution of the Vallecillo Platy limestone indicates that the sediment was deposited on the open shelf. This is supported by the pelagic assemblage and absence of submarine barriers in the region around Vallecillo. This is unusual, because all other platy limestone deposits known from the Jurassic, Cretaceous and early Tertiary formed in restricted basins, such as lagoons or lakes. These platy limestone deposits are famous for the excellent preservation of fossils, but most are restricted in their horizontal extent, in some cases to just 100 m^2. The open marine shelf origin of the Vallecillo Platy limestone deposit appears to be related to the late Cenomanian Oceanic Anoxic Event 2 (OAE 2). On the NE Mexican shelf, stagnant water conditions apparently persisted into the Early Turonian, allowing for widespread formation of platy limestone (Ifrim, 2006). The Vallecillo Platy Limestone Member provides therefore the first evidence for an open marine formation of platy limestone (Ifrim *et al*., 2005b).

Collections

Over the years, two types of collections were initiated: (a) a random collection, which includes specimens unearthed by the quarrymen, as well as other randomly collected specimens from the quarries, mostly without stratigraphic data, and (b) scientific excavations in defined areas, with all lithological and paleontological data recorded and fotodocumented.

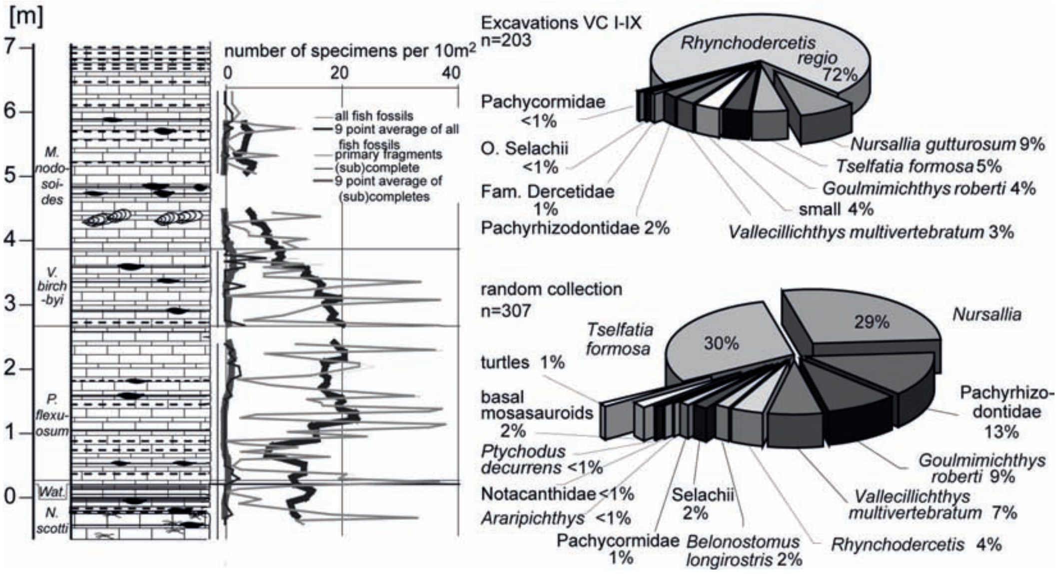

Figure 19. Left: distribution of vertebrate fossils over the Vallecillo section. Right: Comparison of abundances of vertebrate taxa in the random collection (upper) and scientific excavation (lower) shows great differences regarding their shares, comparable to the overall distribution shown in Figure 5. It is thus clear that articulated specimens of *Tselfatia* are greatly preferred towards e.g. *Rhynchodercetis*, a smaller species, which mainly occurs in primary fragments.

Many fossils were collected during these excavation campaigns. The composition of the fossil assemblage at Vallecillo is known from a series of excavations carried out between 2003 and 2006. During excavation, 2100 specimens have been registered and photo-documented, hence not all collected. Both types of collections differ considerably from the results, as shown by Ifrim *et al*. (this volume-b) and in Figures 5 and 19: the random collection, the material of which is mainly housed in the UANL-FCT, Linares, yields many well-preserved specimens and includes rare taxa that yield an insight into the diversity of the Vallecillo biota. Collections based on the excavations, provided few well-preserved specimens, but first confident data on the absolute composition of the Vallecillo assemblage (Ifrim, 2006; Ifrim *et al*., 2007, 2008b; this volume-a).

The number of 510 determined fish specimens reaches statistical significance and allows quantitative analysis of taxon abundances. In general the fish assemblage is characterized by a low taxonomic diversity. Recent studies on the fish fossils include taphonomic interpretations. The abundance of fossils allows the taphonomic interpretation of the three most abundant Vallecillo fishes: *Rhynchodercetis*, *Tselfatia,* and *Nursallia*, all three of which differing in their locomotion type, feeding habits and preferred water depths. They comprise 85% of the excavated, determined fish assemblage (Figure 19), but existed in the Turonian sea without interfering with each other (Ifrim *et al*., 2005a; Ifrim, 2006).

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