

Women from the Americas and their Contribution to Fish Paleontology

Mujeres de América y su aporte a la paleontología de peces

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Abstract

Paleontological studies have traditionally been conducted by male researchers, and the study of fossil fishes, as well as extant ones, has been no exception. However, starting from the last century, female paleoichthyologists have added to the knowledge of this diverse group of vertebrates, and this development has been most notable in Europe. This paper highlights accomplishments reached by women from the American continents who have made outstanding contributions to the origin, evolution, diversification and classification of fishes. Their tireless work to understand the morphological characters that define taxa, ontogeny, homologies, evolutionary patterns, phylogenetic and paleogeographic relationships of fishes, both recent and fossil, is recognized; however, it is necessary to highlight that this has not been an easy process, but the high-quality work and resilience of these great paleoichthyologists has ensured their scientific recognition. Despite many challenges, these women have focused on training new specialists to continue their legacy, in addition to forming a cross-cultural community with those interested in the study of this group and nature in general.

Keywords: Fossil fish diversity, lack of opportunities, resilience, women empowerment.

Resumen

Tradicionalmente los estudios paleontológicos han sido conducidos por investigadores del sexo masculino y no es la excepción cuando se trata del estudio de peces fósiles; sin embargo, en las últimas décadas, mujeres paleoictiólogas se han sumado al conocimiento de este grupo tan diverso de vertebrados, siendo este incremento más notable en Europa. En este trabajo se resaltan los estudios realizados por mujeres de las Américas que han contribuido de manera sobresaliente al entendimiento del origen, evolución, diversificación y clasificación de los peces. Su incansable labor por entender los caracteres morfológicos que definen a los taxones, la ontogenia, las homologías, los patrones evolutivos, las relaciones filogenéticas y paleogeográficas de los peces, tanto recientes como fósiles, es reconocida; no obstante, es necesario resaltar la calidad humana, sencillez y resiliencia de estas grandes paleoictiólogas que han enfrentado retos y obstáculos, y que, a su vez, se han concentrado en formar nuevos especialistas que continúen su legado, además de formar una comunidad intercultural con los interesados en el estudio de este grupo.

Palabras clave: Paleodiversidad de peces, falta de oportunidades, resiliencia, empoderamiento femenino.

Non-technical Abstract

Fish are the most numerous groups of vertebrates in existence and have an extensive fossil record. Studies on fossil fishes began more than a century ago and have been led mainly by men; however, in recent decades, women have played an important role in advancing knowledge of their taxonomy, classification, interrelationships, ecology, and evolution. The history of these

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specialists began in Europe, where they were trained by male experts in the field; some managed to obtain important positions in renowned institutions, but others were not so fortunate. The same was true in countries in the Americas, although there are several examples of women overcoming adversity. The lack of opportunities to find a job that allows them to do research, in addition to the responsibilities they take on if they choose to become mothers and care for their families, are factors that can lead them to seek other possibilities for subsistence. This paper presents the history of the development of fossil fish studies, with an emphasis on the Americas, and highlights the important contributions of some women specialists in the group.

Resumen no técnico

Los peces son el grupo de vertebrados más numerosos que existe y su registro fósil es extenso. Los estudios sobre los peces fósiles comenzaron hace más de un siglo y han sido liderados principalmente por hombres; no obstante, en las últimas décadas las mujeres han desempeñado un papel importante en el conocimiento de su taxonomía, clasificación, relaciones de parentesco, ecología y evolución. La historia de estas especialistas comenzó en Europa, donde fueron entrenadas por hombres expertos en el tema; algunas lograron obtener puestos importantes en instituciones de renombre, pero otras no tuvieron la misma suerte. Lo mismo ocurrió en países de las Américas, aunque existen varios ejemplos de superación. La falta de oportunidades para conseguir un trabajo que les permita hacer investigación, además de las responsabilidades que adquieren si optan por la maternidad y el cuidado de la familia, son factores que pueden llevar a buscar otras posibilidades para subsistir. En este trabajo se muestra la historia del desarrollo de los estudios en peces fósiles, haciendo énfasis en las Américas, y se resaltan las importantes contribuciones de algunas mujeres especialistas en el grupo.

1. Introduction

Certainly, the study of fossil fishes is not as popular as that of other vertebrates, such as dinosaurs and mammals, dinosaurs alone have an enormous attraction for the public, as well as the scientific community. Nevertheless, a recent study reveals that fishes occupy second place in description of new species, mainly due to their 400 million years of history and aquatic lifestyle that facilitates their rapid burial and preservation (Wang *et al.*, 2025).

The list of women dedicated to the study of fossil fishes from the Twentieth Century reveals significant accomplishment and high-quality science. Most of them were trained by male geologists dedicated to paleontology, because this field has been dominated nearly exclusively by men. The number of women interested in the study of fossils has increased during the last few decades, especially in some continents, although the discipline of studying fossil and extant fishes is still dominated by male colleagues all over the world (Arratia, 2021). This is not surprising, because, even today, we live in a world where advances in fields of science and technology are dominated by males. Women are under-represented globally in many facets of science; their participation in scientific works, authorships, editorial boards, research leadership roles, and academic positions is low compared to males (Turner, 2021; Wang *et al.*,

2025). However, as we will demonstrate below, a survey of the current situation and comparison with the Twentieth Century reveals interesting differences among continents and new influences and participation in the field of paleoichthyology.

Many issues are involved, as for example, cultural and political conditions in each country, gender and racial policies, economic situation, family responsibilities, role of women as mothers, *machismo*, sexual harassment, and the lack of opportunities to develop as researchers. These conditions can be quite different across countries, especially in different socio-economic levels. Nevertheless, many women have overcome the hurdles and have made outstanding contributions to the understanding of the diversity and evolution of fishes.

The goal of this paper is to show the participation and scientific contribution of women of the Americas (North and South) in the field of fish paleontology, in education, administration and research in their respective countries and internationally. Since we need a point of comparison, we begin by analyzing the historical development of the field in Europe, and then we focus our analysis in North and South America, where we proceed alphabetically with our presentation. For this purpose, we focus on females who systematically study and do research on fossil fishes, thus occasional contributors, such as Brigida de Gracia

and her study on otoliths (e.g., Lin *et al.*, 2019; O’Dea *et al.*, 2024) and Lydia S. Tackett and her studies on ichthyoliths (e.g., Tackett *et al.*, 2022) are not listed below. The information presented here comes from a review of their works displayed on their affiliated institutions’ webpages, ResearchGate pages, Google Scholar, and personal websites, as well as direct communication with the scientists.

2. Overview of Women in Paleoichthyology in the Twentieth Century

As in other branches of paleontology, the first paleoichthyological studies were conducted by men. Such is the case of Louis Agassiz, a European naturalist and geologist who wrote four volumes (1833–1843) dedicated to the study of more than 1,700 fossil fishes. Another important contributor was Arthur Smith Woodward, who authored the *Catalogue of the Fossil Fishes in the British Museum (Natural History)* (1889–1901). Furthermore, from the USA, Edward D. Cope, despite his short life (1840–1897), had an enormous contribution, with about 1,000 new species from various fish clades (and other vertebrates)—an author whose contribution cannot be ignored. Fish taxonomy was not only restricted to male contributions, but also major texts on fish anatomy, which are still in use, were published by male European researchers. Much later from North America, William K. Gregory wrote the classic anatomy text *Fish Skulls* (1933) on actinopterygian skulls that is also still used today.

In the first half of the Twentieth Century, some European male paleontologists dedicated their lives to the study of vertebrates, especially fishes. Many of them have outstanding and lasting contributions, for instance, Camille Louis Arambourg, P. de Saint-Seine (France), and Eric A. Stensiö (Sweden). In the second part of the century, fish paleontology flourished, exemplified by such workers as J.-P. Lehman (France), Eric A. Stensiö, Tor Ørvig and Erik Jarvik (Sweden), and Dimitri V. Obruchev (Russia). These male

paleontologists developed different areas of research on fossil fishes and were fundamental in developing students and followers from Europe and abroad. For instance, D. V. Obruchev in Moscow and J.-P. Lehman in Paris formed research centers at their respective institutions. The group of D. V. Obruchev included several female students from the Soviet Union, such as Elga Mark-Kurik from Estonia, Valia Karatajute-Talimaa from Lithuania, L. Lyarskaya from Latvia, and A. A. Kazantseva-Selesneva, L. I. Noviskaya, Eugenia Sytchevskaya, and Emilia Vorobyeva from Russia. Each of these women became outstanding leading scientists in their respective countries; some of them occupying high academic positions and administrative posts. At least three of them are coauthors of the *Fundamentals of Paleontology, Vol. XI (Agnatha, Pisces)* with D. V. Obruchev as volume editor (1964). Similarly, another group including female students was formed in Paris under the guidance of J.-P. Lehman with Lawrence Beltan, Cecile Poplin, Sylvie Wenz, Nicole Tabaste, Monique Véran and Mireille Gayet.

Independent of these two main centers of paleoichthyologists, the first studies of fossil fishes developed by women started in Europe earlier in the first half of the Twentieth Century. For instance, the Polish colleague Zinaida Gorizdro-Kulczycka and her studies on Middle Devonian fishes (1934, 1937) from Poland should be mentioned, as well as the accomplishments of Dorothy Helen Rayner, from Britain, who dedicated her life to the study of Mesozoic fishes. Rayner was one of the first women to get a PhD at Cambridge in 1938, as well as a tenured academic post in an English geology department in 1939 (Turner, 2021). Another pioneer of fossil fish studies is Margaretha Brongersma-Sanders born in The Netherlands more than 100 years ago; she studied the taxonomy of recent and fossil fish and preservation processes. She was the first to categorize fish mass mortality and its causes (Turner and Cadée, 2005). These women, and probably some others who had important contributions to the knowledge of

fossils during the first part of the Twentieth Century, had to face many obstacles, including a lack of civil rights and the Second World War.

During the second part of the Twentieth Century, there was an increase in the number of female fossil fish specialists around the world; some of them acting not only as scientists, but leaders in their institutions, becoming highly influential nationally and internationally. One excellent example is the Chinese paleoichthyologist Meemann Chang, who did her Master's thesis in Moscow under O. P. Obrucheva and continued with her PhD dissertation in Sweden with E. A. Stensiö and E. Jarvik. This outstanding paleoichthyologist has studied the taxonomy, phylogeny, paleoecology and paleozoogeography of Paleozoic, Mesozoic and Cenozoic fish faunas (*e.g.*, Chang and Jin, 1996; Chang and Miao, 1999), but her most important contributions are those focused on the study of early sarcopterygians from the Lower Devonian of Yunnan, China (*e.g.*, Chang, 1991, 1995). She was instrumental in the growth of IVPP (Institute of Vertebrate Paleontology and Paleoanthropology, Beijing), one of the most important academic institutions in China (Miao, 2010).

The academic and working conditions of female scientists dedicated to fishes in the second part of the last century was different from today, and Europe is an excellent example illustrating this difference. For example, during that period the Centre National de la Recherche Scientifique of France had several research positions that were filled with women who became leading paleoichthyologists internationally, such as Cécile Poplin with major contributions to the study of Paleozoic actinopterygians from France, Spain and USA (Poplin, 1973, 1974, 2004; Poplin and Lund, 1995, 2000; Schultze *et al.*, 2022); Sylvie Wenz with studies on Cretaceous actinopterygians mainly from France and Spain with various collaborators (Wenz, 1967, 1989, 2003); Lawrence Beltan dedicated a significant portion of her research to the important fish fauna of the Permian of Madagascar (Beltan, 1968, 1977, 1996); and Mireille Gayet with a

great number of publications on Cretaceous and Cenozoic teleosts mainly from Europe, Africa and South America (Gayet, 1981, 1986; Gayet and Meunier, 2003). More or less contemporaneous, another strong group of female paleontologists from Russia and countries of the former Soviet Union that were educated in Moscow under the famous paleontologist O. V. Obruchev had formal research/academic positions, making female paleontologists a strong, working force in European academic institutions. Olga Afanassieva, Valia Karatajute-Talimaa, Al'vina Kazantseva-Selesneva, Natascha Krupina, Elga Mark-Kurik, Tiu Märss, Larissa Novistskaya, Eugenia Sytcheykaya, and Emilia Vorobyeva are some examples.

From the times mentioned above—being a prominent period for the development of women in paleontology and natural sciences in general—to the present, some major political/academic/social changes occurred in Europe, because once these colleagues retired, many of their positions were cancelled, so there has been a consistent loss in research/academic positions, creating a major problem for young researchers in need of work, ultimately affecting fish paleontology. Thus, the present European landscape looks very different; the current force of women paleontologists is represented by very few in official positions, and these are centered mainly in Germany and England. From Germany, we should mention two with official positions: B. Reichenbacher and E. Maxwell. Bettina Reichenbacher, a full professor of Paleontology at the Ludwig-Maximilians University (LMU) in München, is an influential paleontologist dedicated to the study of fish systematics and evolution—fossil and extant—with a strong focus on otoliths from Europe, as well neighboring continents (*e.g.*, Reichenbacher *et al.*, 2007; Altner *et al.*, 2017; Gierl *et al.*, 2022). Reichenbacher is influential in the education of fish paleontologists from Europe and other continents and postgraduate fellows. Additionally, she is influential at administrative university levels as vice-Dean and Dean, as well as the Vice-President and President of the

German Paleontological Society and in numerous committees associated with research funding and fellowships. She believes that she had two main roles in all of these committees: (1) to remind people that paleontology is an important science and needs to be promoted, and (2) to remind people that women are underrepresented, but that good women exist and that they need mentoring and support to find permanent employment in academia. Erin Maxwell, a curator of fossil aquatic vertebrates at the State Museum of Natural History in Stuttgart (SMNS), is dedicated to the study of actinopterygians, especially basal teleostomorphs (Maxwell and Cooper, 2025; Maxwell *et al.*, 2025; Cooper *et al.*, 2024); she has developed a research center that includes postdoctoral fellows and other young paleontologists involved in fish research. A third person that should be mentioned, Adriana López-Arbarello (Figure 1), who was born in Argentina, but has lived in Germany for many years, has produced a series of major publications on neopterygians (López-Arbarello and Sferco,

2018; López-Arbarello *et al.*, 2023; Ebert and López-Arbarello, 2025) funded by the German National Science Foundation. As has happened with other female researchers all over the world, the frustration and disappointment of not being able to obtain a position after many years forced her to abandon the sciences, in what it is certainly a stressful and painful loss for our small community of female paleontologists.

Examples from Britain with official positions that have been highly influential on fish paleontology worldwide are S. Mahala Andrews, Moya Smith, and more recently Zerina Johanson and Sam Giles. S. Mahala Andrews was a fish paleontologist working as the Senior Scientific Officer, Department of Geology, at the National Museum of Scotland, who passed away in 1997. Mahala was characterized by a very kind and sweet personality, but also by a strong involvement in her research that helped her to survive her PhD advisor, who had abusive demands on his students, including claiming first authorship in her and other students' publications. (We mention especially this as an example of behaviors that we hope others will not suffer again.) Her research was focused on the fossil lobe-finned fish (sarcopterygians) that would later evolve into the first land vertebrates, an important subject that became the principal foundation on which research on the origin of amphibians is based (*e.g.*, Andrews and Westoll, 1970; Andrews, 1973, 1977; Andrews *et al.* 2005, which was published after her death). Moya Meredith Smith, currently a Professor Emeritus at King's College London, has focused her research on the evolution and development of patterning in the vertebrate dentition. She has about 140 scientific publications (*e.g.*, Smith and Coates, 2001; Reisz and Smith, 2001) in highly reputed scientific journals, and recently, she has a productive collaboration with Z. Johanson (*e.g.*, Smith and Johanson, 2003; Smith *et al.*, 2023). Zerina Johanson is currently a Researcher at the Natural History Museum in London, dedicated to the understanding of the evolution and development of the early vertebrate



Figure 1. An afternoon break during the 3rd International Meeting on Mesozoic Fishes held in Serpiano, Switzerland in 2001. From left to right: Katia A. González-Rodríguez, Francisco Poyato-Ariza, Adriana López Arbarello caring for her baby, Mario Suárez, Gloria Arratia, and Valeria Gallo. In the background of the photo K. A. Frickhinger.

skeleton, focusing on dentition and postaxial skeleton (e.g., Johanson, 2021, 2022; Pears et al., 2025). With currently ca. 214 publications, she is a powerful leading scientist and very influential in fish paleontology, with her first publications focused on Australian material (e.g., Johanson, 1995), including a few on marsupials of North America. Additionally, Johanson is editor of the *Journal of Systematic Palaeontology*, a leading journal in its field. Sam Giles (Senior Researcher at the University of Birmingham) studies the anatomy, relationships and macroevolution of Paleozoic and Mesozoic fossil fishes. She is interested in the origins and evolutionary success of bony vertebrate groups and the evolution of the vertebrate body plan. Currently she has 113 publications (e.g., Brazeau et al., 2020; Friedman et al., 2025; Giles et al., 2025) and has an active research program that trains students and postdoctoral fellows.

In addition to the female paleontologists mentioned above, there are a few more from other European countries, such as Austria, France, Poland, Sweden, and Russia; most of them have a position in a university, museum, or geological survey.

3. Female Paleichthyologists in the Americas

The beginning of the involvement of women in fish paleontology in North America is much later than in Europe, with the earliest one apparently being Barbara Stahl, who was one of the few female students of A. S. Romer at Harvard University. After working intensively on her PhD dissertation on holocephalians, she was able to defend it (Stahl, 1965) within about a year and a half of starting. A number of women from the New World (see below) have contributed greatly to the knowledge and understanding of the diversity, evolution, ecology and distribution of fossil fishes. The following list of American women scientists (arranged by country geographically from north to south) is probably far from complete, since there are many who,

after showing an initial interest, abandoned the field because of scarcity of positions and ended up doing something different or simply leaving the world of academia.

3.1 North American continent

3.1.1 Canada

Currently, and to our best knowledge, only one female researcher on fish paleontology has an official academic position in Canada. **Alison Murray** is a full professor at the University of Alberta, working on systematics of fossil and recent teleost fishes. Her research projects include, among others, marine Cretaceous fishes from North America and freshwater fishes from the Tertiary of Africa and Asia, which are largely based on her findings from her field expeditions. She has published more than 120 research articles (e.g., Murray and Wilson, 1999, 2013; Dueck and Murray, 2024). In addition to her teaching and research activities, Alison is an associate editor for *Journal of Paleontology and Palaios*. She is the managing/founding editor for *Vertebrate Anatomy Morphology Palaeontology* (VAMP), a journal with absolutely no fees for any author or reader; it is supported by the Open Journal System, which is in turn supported by numerous university libraries. Additional service to the scientific community includes manuscript reviews for many journals and grant reviews for institutions in Europe and the USA. Furthermore, Alison has been a member of two committees for the Society of Vertebrate Paleontology and was a founding member and Treasurer for the Canadian Society of Vertebrate Palaeontology. She was the Interim Chair for her department from July 2023 to June 2024, being another example that women can excel in research, as well as in administrative positions and duties.

3.1.2 United States

Among female colleagues, we would like to honor some that are not with us anymore, but have contributed for years to field work, research and teaching to the knowledge of fossil fishes. Among these we should cite two

who were interested in the fishes of the Carboniferous Gulch Bear site in Montana, USA. The Bear Gulch fauna is characterized by an enormous fish diversity with extraordinary preservation. **Wendy Lund** collaborated with her husband, Richard Lund, at this famous site. During her career, she took care of the curation of the fossils at Adelphi University, Garden City, New York and the Carnegie Museum, Pittsburg, Pennsylvania, as well as a variety of businesses from domestic to scientific during long periods working in the field. She coauthored a paper on coelacanthiforms (Lund and Lund, 1984). Later she was honored with the dedication of a new genus of the palaeoniscoid radinichthyid, *Wendichthys*, with at least two species (Lund and Poplin, 1997). Working at the same fossiliferous site was a female student, **K. A. Lowney**, who produced two publications, but she left the sciences to work in a law office.

Barbara Stahl passed away in 2004. She had a teaching position at Saint Anselm College, Manchester, NH, especially dedicated to medical students. She wrote a PhD dissertation under A. S. Romer at Harvard University and continued studying chondrichthyans in the little free time that she had left from her teaching position. Stahl is the author of a teaching volume on *Vertebrate History: Problems of Evolution* (Stahl, 1974) and “Holocephali” for the *Handbook of Paleoichthyology* (Stahl, 1999). Her publication on the structure of the early chimaroid dentition was published posthumously (Stahl, 2004). As noted by H.-P. Schultze (2004, p. 9) in his obituary for Barbara, her research was second to her teaching, even so, “she published and collaborated on many excellent publications”.

The current community of North American females working in fossil fishes is small even though the continent has a magnificent diversity of sites. Among the group, at least two are currently retired, some are near retirement, and the ones that have some official positions have such a heavy teaching load that rarely time is left for the development of a research project; others simply are contributing as associate researchers at some academic institutions. To

our best knowledge, there is none holding a research position in a museum, though there are many such positions. They all have teaching positions and are listed alphabetically below.

Gloria Arratia (Figures 1-4, 6). She is a good example of how some people working in extant fishes got involved in fossils. She began studying the first Jurassic fossil teleosts of northern Chile, recovered by a team from the Geological Survey of Chile in Antofagasta (see Nelson, 2010). She had at that time a strong training in the anatomy of fishes, with her education and research being on extant fishes. Thus, Arratia, fascinated by the extraordinary preservation of soft and hard tissues of the fossil fishes, obtained professional training on fossils and published her first papers on the subject (*e.g.*, Arratia, 1981; Arratia *et al.*, 1975a, b; Arratia and Schultze, 1985). After gaining more knowledge, she broadened her interest to basal teleosts (*e.g.*, Arratia, 1997, 1999, 2013) and topics related to their early diversification and evolutionary trends (*e.g.*, Arratia, 2001; Arratia and Schultze, 2024). By doing this, she also got involved in understanding the homologies of several structures that included fossil and recent evidence (*e.g.*, Arratia, 2008; Arratia *et al.*, 2001; Schultze and Arratia, 2013).

When she realized how little participation fossil fishes had in international meetings of paleontological societies, she initiated the international meetings “Mesozoic Fishes” and has been the editor-in-chief of five volumes entitled *Mesozoic Fishes* (59 women contributed in 147 peer-reviewed chapters; 36 of which by women from North and South America; see Figure 5). She officially retired in 2005 but continues with her research as Associate Researcher and Research Professor of the University of Kansas. She is the author of about 300 publications on fossil and extant fishes, editor of 12 books dedicated to fishes, and has seven fish taxa dedicated to her name (*Lepidotes gloriae* Thies, 1989; *Arratiaichthys Richter* and Breitkreuz, 1997; *Arratiaelops Taverne*, 1999; *Plesiomyxocyprius arratiae* Liu and Chang, 2009; *Orestias gloriae Vila et al.*, 2010;

Diplomystes arratiae Muñoz-Ramírez et al., 2023; and *Moldavigibius gloriae* Reichenbacher and Bannikov, 2025). She is currently working on the production of the *Handbook of Paleichthyology*, Vol. 8C, Actinopterygii IIIa, Teleostomorpha.

Sarah Z. Gibson (Figure 2) is an Assistant Professor of Geology in the Department of Atmospheric and Earth Sciences at St. Cloud State University in Minnesota, USA. Her research focuses on the evolutionary relationships and major changes occurring in stem actinopterygian fishes in the Early Mesozoic, an exciting time in the history of the Earth. Her work incorporates anatomy and morphology, within a phylogenetic context, to address questions related to how these fishes adapted and evolved to exploit new ecological opportunities following the end-Permian extinction event (e.g., Gibson, 2013a, b, 2015, 2016, 2018). Since 2019 she has participated in 16 presentations in scientific meetings. Additionally, she has a successful training research program mentoring undergraduate students. Two Master students have already graduated under her guidance.

Terry Grande (Figure 2) has been a Full Professor at Loyola University of Chicago, IL, USA for more than two decades, teaching biological subjects and doing research related to the anatomy, early development, evolutionary relationships and historical biogeography of teleost fishes, focusing on Ostariophysi (e.g., Grande and de Pinna, 2004), with numerous publications on the anatomy and phylogenetic relationships of euteleosts (Grande et al., 2018, Grande and Wilson, 2021) and gonorynchiforms (Grande, 1999; Grande and Grande, 2008; Grande and Poyato-Ariza, 1999, 2010; Grande and Arratia, 2010), including the edition of a book on this subject (Grande et al., 2010). She has published numerous research articles (ca. 60), and currently she is one of the authors of the well-known and highly cited book *Fishes of the World* (Nelson et al., 2016), with the next edition currently in preparation. She has used her experience and knowledge about fishes as a mentor of numerous students, as an editor

in journals, such as *Journal of Vertebrate Paleontology*, and currently is the Editor in Chief of *Ichthyology and Herpetology*, the journal of the American Society of Ichthyology and Herpetology (ASIH). She has also been involved in the organization of scientific meetings (e.g., Society of Vertebrate Paleontology, 2008) and in different committees of the ASIH.

Eileen D. Grogan, currently Professor Emeritus at Saint Joseph's University of Philadelphia, United States, has studied the origin, diversity and evolution of early chondrichthyans, describing new genera and species coming from the Paleozoic sediments of Montana, USA. She has also collaborated extensively with Richard Lund, describing new species of actinopterygians (e.g., Grogan and Lund, 2009; Grogan et al., 2012, 2014, 2025; Lund et al., 2025). Currently she has 83 publications, and despite the fact that she is retired, she continues working with major research problems on fossil fishes (e.g., Jobbins et al., 2024). Additionally, she was active and influential in the education of graduate students at Saint Joseph's University for many years.

Jennifer A. Lane is a young fish paleontologist who is currently a Research Associate with the American Museum of Natural History



Figure 2. A nice evening during the 5th International Meeting on Mesozoic Fishes held in Coahuila State, Mexico in 2010. From left to right: Terry Grande, Mark Wilson, Gloria Arratia, Hans-Peter Schultze, Kathryn Mickle, Sarah Gibson, Matthew Davis, and Christopher Fielitz.

in New York. Although her first contributions were dedicated to chondrichthyans (*e.g.*, Lane, 2010; Lane and Maisey, 2012), during her professional stay in München, Germany with a two-year research fellowship under the project “The Dynamic of the Solnhofen Archipelago” (with Martina Kölbl-Ebert), she made important contributions to the knowledge of Jurassic neopterygians (*e.g.*, Lane and Ebert, 2011, 2015) and to the ecology of Jurassic fishes of Bavaria (Ebert *et al.*, 2015).

Juan Liu is a young fish paleontologist working as Assistant Adjunct Professor, Department of Integrative Biology and Assistant Curator, University of California Museum of Paleontology, University of California, Berkeley. She is interested in otophysans, particularly cypriniforms, a field where she has already contributed (*e.g.*, Liu, 2021; Liu and Chang, 2009; Liu *et al.*, 2015; Liu *et al.*, 2025). She has served as an associate editor of the *Journal of Vertebrate Paleontology* since 2023 and collaborated with the Program Committee at the meetings of the Society of Vertebrate Paleontology. Juan is optimistic that although paleontology, particularly the participation of women in the Americas, is not currently at its strongest representation, with the rise of new technologies, such as CT scanning and computational modeling, combined with the general open-mindedness and innovation of many women scientists, a renaissance will come—one that transforms classical paleontology into a new era powered by digital tools.

Kathryn Mickle (Figure 2) is currently a tenured Associate Professor in the College of Life Sciences, Department of Biological and Chemical Sciences at Thomas Jefferson University. We believe that Kathryn is an excellent example of what teaching responsibilities may mean. Her responsibilities focus on human gross anatomy, and she teaches undergraduate lecture and lab courses, as well as graduate level human gross anatomy lecture and dissection labs for a Physician Assistant program. She is responsible for teaching

about 100 physician assistant students in lecture and about 50 students in the dissection lab (Summer and Fall semesters). She is the course director for lecture and lab-based courses for programs across two different campuses and has lab director responsibilities on both campuses as well. Her research projects address fundamental problems with lower actinopterygian fishes, primarily the need for detailed taxonomic descriptions and investigations into morphological characters (*e.g.*, Mickle, 2013, 2015, 2017, 2018). Recently, she contributed as a coauthor to the *Handbook of Paleoichthyology, Actinopterygii I* (see Schultz *et al.*, 2022).

Lauren Sallan currently is the Head of Macroevolution Unit of Okinawa Institute of Science and Technology Graduate University in Japan. She is a young American scientist that after holding a few academic positions in the USA after her graduation in 2012 (Michigan Fellow, which was an appointment as non-tenure track faculty, and in 2014 she officially joined the faculty at the University of Pennsylvania), accepted an academic job outside the country; there is the hope that she will return to the USA in the future. She describes herself “as a next generation paleobiologist and ichthyologist applying cutting edge developments



Figure 3. Three generations of paleoichthyologists during the 6th International Meeting on Mesozoic Fishes held in Vienna, Austria in 2013. From left to right: Katia A. González-Rodríguez, Soledad Gouiric Cavalli, and Gloria Arratia.

in 'Big Data' analytics to reveal how evolution happens at the largest scales (macroevolution). She uses the vast fossil and living record of fishes, and the ecosystems they inhabit, as a database to determine why some species persist and diversify while others die off, how novel features evolve, and how ecological conflicts and environmental shocks drive evolution at immense time scales." Currently she has published about 30 articles (e.g., Sallan, 2012, 2014, 2020; Sallan and Coates, 2013) and contributed to numerous national and international scientific meetings.

3.1.3 Mexico

The development of fish paleontology in Mexico was initiated recently, when Shelton P. Applegate took residence in Mexico and developed research and educational programs in Ichthyology and Paleoichthyology. **Katia A. González Rodríguez** (Figures 1, 3, 4) did her PhD with Shelton P. Applegate as her advisor (González-Rodríguez, 2004), describing new species of the extinct family *Macrosemiidae*, which is the first record of this family in the Americas (González-Rodríguez and Reynoso-Rosales, 2004; González-Rodríguez et al., 2004). She is currently the only female fish paleontologist to have an academic position in the country, studying the fauna of an Albian marine locality of Hidalgo central Mexico where many new species of teleosts have been described (e.g., González-Rodríguez and Fielitz, 2008; Fielitz and González-Rodríguez 2008, 2010; Arratia et al., 2018; Baños-Rodríguez et al., 2020), as well as two new families of extinct fishes [*Pseudomonocentridae* (González-Rodríguez et al., 2013); *Xeneichthyidae* (Arratia and González-Rodríguez, 2024)]. In addition to her research program concerning fossil fishes, Katia González-Rodríguez has an intense program of teaching activities and the promoting of sciences and protection of fossils in the region (González-Rodríguez et al., 2023). She is the curator of the Paleontological Museum at the Autonomous University of Hidalgo and has edited two books related to the paleodiversity and conservation of

the Mexican heritage (González-Rodríguez et al., 2009; Cuevas-Cardona and González-Rodríguez, 2015). Under her mentorship a few women have studied paleontology. **Citlalli Hernández Guerrero** studied the pachyrhizodontids of the Albian Muhi Quarry of Hidalgo during her Master's and the elopomorphs of the same locality for her Doctorate (Hernández-Guerrero et al., 2021), but she did not continue in the field. Only one of her former students remains active (Rocío E. Baños Rodríguez).

Rocío E. Baños Rodríguez (Figure 4) is a young woman from Mexico who did a taphonomic study of the extinct aulopiform species *Enchodus* from the Albian Muhi quarry of the state of Hidalgo with the intention to become an expert on fish taphonomy, but she had to start with learning fish anatomy; for this reason, her Master's focused on describing a new species of ichthyodectiform from the Albian Muhi quarry in Zimapán, Hidalgo (Baños-Rodríguez et al., 2020). Her desire to become an expert in fish taphonomy led her to seek specialists in other parts of the world for support; however, the responses from researchers were not very encouraging, because taphonomic processes in fish have been little studied. In addition, she needed to obtain a scholarship to study for her doctorate in another country. After



Figure 4. Working in the first author's office in January 2014. From left to right: Rocío E. Baños Rodríguez, Gloria Arratia, Katia A. González-Rodríguez and Hans-Peter Schultze.

almost two years of searching for opportunities, without losing the strength to achieve her goal, she was accepted at the Université du Québec à Rimouski under the supervision of Richard Cloutier. She is currently pursuing her doctoral studies in Canada, researching the stomach contents and the pelvic girdle of *Elpistostege watsoni*, the sister group of all tetrapods (Baños-Rodríguez *et al.*, 2024; Cloutier *et al.*, 2020).

Two other students from Mexico, supervised by Jesús Alvarado Ortega from the Universidad Nacional Autónoma de México, UNAM, enthusiastically began their bachelor's and master's degrees. **Abril Alaniz-Galván** (2011) studied Paleocene perciform fish from Chiapas, México, and **Pilar Melgarejo-Damián** (2011) worked on Ellimmichthyiformes from the Albian of Puebla, Mexico. However, neither of them continued their training as paleoichthyologists. Currently, both have jobs unrelated to this specialty that once fascinated them, perhaps due to a lack of opportunities at the time and the need for economic

stability. Two new students of Alvarado-Ortega began studies on fossil fish of Mexico recently. **Nayeli Lupercio Espericueta** is currently working with crossognathiform fishes (Lupercio-Espericueta & Alvarado-Ortega, 2025), and **Stephanie Pacheco-Ordaz** focused on the Pycnodontiformes from the Tlayúa Quarry in Puebla (Pacheco-Ordaz *et al.*, 2025a, b).

A new master's student under the supervision of the first author of this contribution (**Ihory J. Ponce Bustos**) is currently training to study Turonian fish from Xilitla, San Luis Potosí, a town in central Mexico with diverse groups of teleosts. It is hoped that in the near future she will be able to obtain a position as a professor-researcher at the university where she trained.

3.2 South American continent

It is noteworthy to mention that the development of women in this field is very different depending on the country. For example,

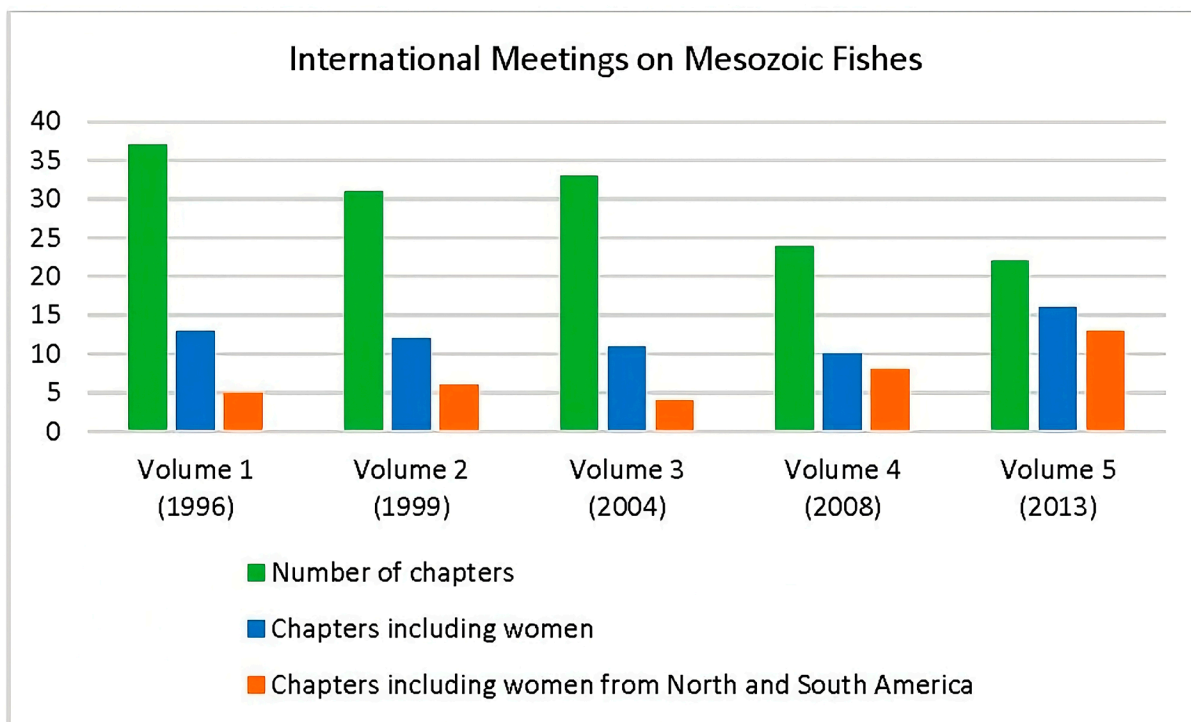


Figure 5. The international Meetings on Mesozoic Fishes began in 1993. They were held every four years until 2013, with the last meeting in Vienna, Austria. As a result of the 1993-2010 meetings, five volumes entitled Mesozoic Fishes (1-5) were published. Over the years the number of women contributing to the volumes increased, as did the number of women from North and South America.

paleontology in Argentina has been traditionally a “respectful” branch of science, and it is not surprising that the first female paleontologist from South America is from Argentina. At a time when it was rare for women in South America to study at universities, **Mathilde Dolgopol de Sáez** earned her doctoral degree in 1927 and has the distinction of being the first female vertebrate paleontologist of Latin America and of the Americas as well, studying fishes (and birds). A few years later, another Argentinian woman, **Andreina Bocchino de Ringuelet**, was even more influential in the development of paleontology in her country, as shown below. Chile, without a tradition in vertebrate paleontology (an approach that has changed dramatically in the last 20 years), has produced one of the authors of this contribution, **Gloria Arratia** (Figures 1-4, 6), who was born in Santiago, Chile; she initiated the study of fossil fishes in Chile in 1970. More recently, **Martha Richter** in Brazil began studies on fossil fishes and other vertebrates from South America and other Gondwanan continents (see below). These four women can be considered as pioneers in the development of fish paleontology in South America. As above, the following presentation follows an alphabetic order.

3.2.1 Brazil

Camila Cupello, a Brazilian researcher, is Associate Professor at the Universidade do Estado do Rio de Janeiro, Brazil. She obtained a permanent position in January 2025 that includes both teaching and conducting her research in fish paleontology. However, as she mentions, the teaching activity is quite heavy, so she often needs to work in the evenings, on weekends, and during vacations to carry out her research activities. Nevertheless, she has published more than 26 papers and supervises undergraduate and graduate students and is Associate Editor for *Acta Palaeontologica Polonica*. She is dedicated to the study of Mesozoic sarcopterygians; however, she has mainly devoted herself to studying the pulmonary

system of extant coelacanths and the origin and evolution of lungs in vertebrates (*e.g.*, Cupello *et al.*, 2015, 2017, 2022, 2024).

Valeria Gallo (Figure 1), a Brazilian paleoichthyologist, is Full Professor at Rio de Janeiro State University where she has developed an active research program, including the education and professional training of numerous undergraduate and graduate students, and postdoctoral researchers. She has played and is playing an important role in Brazilian paleontology and the Society of Paleontology of Brazil where she has contributed to the organization of some major activities and national and international scientific meetings concerning paleontology and protection of fossils. She has studied various groups of actinopterygians (*e.g.*, Gallo, 2005; Gallo and Figueredo, 1999), but she has also contributed to the knowledge of chondrichthyans and sarcopterygians from Brazil. Valeria has also conducted paleoecological and paleogeographical studies of certain taxa from important fossil localities in the country (*e.g.*, Gallo *et al.*, 2021, 2022, 2025; Echeverria and Gallo, 2015), as well as in other countries and Antarctica (Gallo *et al.*, 2011; Gallo *et al.*, 2025).

Maria Claudia Malabarba, after her PhD graduation, worked as a researcher for over 25 years in the paleontology laboratory at the PUCRS Museum of Science and Technology, where she conducted research on fossil fish (*e.g.*, Malabarba, 1988; Malabarba and Lundberg, 1985; Malabarba *et al.*, 1998; Malabarba and Malabarba, 2010). The paleontology researcher position was cut from the institution's budget, and currently there are no paleontologists working there. After that, she joined the ichthyology laboratory of the Zoology Department at the Federal University of Rio Grande do Sul, Brazil. In the absence of a paleontology laboratory and given the immediate availability of other techniques for comparative biology studies in modern fish, she became interested in molecular research in

fish and, in fact, feels more comfortable and happier conducting this type of research, which has resulted in a loss for fish paleontology.

Martha Richter was born and grew up in Brazil where she began her academic activities as a fish paleontologist; later on, she moved to England and recently retired from her curatorial research position at the National History Museum in London where she remains as an associate. Her interest in fossil fishes focuses on their anatomy and histology of hard tissues, phylogenetic interrelationships and the geological context of the places where the fossils are found (*e.g.*, Richter, 1989; Richter and Toledo, 2008; Richter *et al.*, 2017, 2022).

3.2.2 Argentina

Mercedes Azpelicueta is Principal Researcher of the Argentinean Research Council (CONICET) at the National University of La Plata, with residence at the Museo de la Plata, Vertebrate Zoology Department (she is currently retired but still associated with the institution). Mercedes is a well-known Argentinian ichthyologist that works on freshwater fishes and has an extensive record of important publications, for instance, her contributions to the knowledge of primitive South American siluriforms (Azpelicueta, 1994). Later, in her professional career, she became involved with fossil fishes working often with Alberto L. Cione and more recently with Soledad Gouiric Cavalli, all at the Universidad Nacional de la Plata and Museum. In the field of fish paleontology, Mercedes has made outstanding contributions, especially the descriptions on fossil catfishes, which are significant in the understanding of the early evolution of Siluriformes (*e.g.*, Azpelicueta and Rubilar, 1998; Azpelicueta and Cione, 2011; Azpelicueta *et al.*, 2016).

Andreína Bocchino de Ringuelet is considered one of the first paleoichthyologists of Argentina and also of both American continents. At a time when not many women were working in academia, much less in

paleontology, her strong personality and decisive attitude were a major force in the development of paleontology in Argentina. In 1959 she and Rosendo Pascual generated a project to create the Bachelor's in Paleontology of Vertebrates in the Faculty of Natural Sciences and Museum of the National University of la Plata; also, she became the first woman acting as Vice-President of the Paleontological Association of Argentina for three periods between 1965 and 1973. In addition to her work in administration, she described a few fossil fish species (*e.g.*, Bocchino, 1967, 1973, 1974, 1978). (As was common at that time, she used her husband's surname as her second surname.)

Mathilde Dolgopol de Sáez has the distinction of being the first female vertebrate paleontologist of both American continents, studying fishes and birds. She was a student in the Universidad Nacional de La Plata and became an assistant in the department of mineralogy of La Plata Museum. The main part of her research was done on fishes (Dolgopol de Sáez, 1949a, b) and birds (1927–1940). In addition to her pioneering scientific contributions, she was a founding member of the Paleontological Association of Argentina, where she wrote a doctoral dissertation on fossil invertebrates in 1955. (As was common at that time, she used her husband's surname as her second surname.)

P. Guillermina Giordano (Figure 6) is a young ichthyopaleontologist with a teaching position at the University of San Luis, Argentina and a strong field work program, recovering new fossil vertebrates in northern Argentina. Her research interests are Cretaceous fishes from Argentina, an interest that began with her PhD thesis on fossil fishes from La Cantera Formation, San Luis. Because of her docent position at the university, her time for research is limited, a constraint shared with many of the women mentioned in this contribution; still Guillermina continues with field work and publications, also exploring Triassic fishes from Argentina, usually with other

female colleagues and students (e.g., Giordano *et al.*, 2016, 2018, 2023).

Soledad Gouiric Cavalli (Figure 3) is a young paleoichthyologist at the Argentinean Research Council (CONICET), based in the Vertebrate Paleontology Division of the La Plata Museum, National University of La Plata, Buenos Aires. Her research focuses on the anatomy, systematics, taxonomy, phylogeny, paleoecology, and paleobiogeography of fossil actinopterygians and chondrichthyan from Argentina and Antarctica, with particular emphasis on teleostomorphs and holosteans of the Neuquén and Larsen Basins. By combining traditional paleontological approaches with emerging technologies, her work seeks to deepen our understanding of the evolutionary history of Southern Hemisphere fish faunas. She has published about 70 peer-reviewed papers (e.g., Gouiric Cavalli and Arratia, 2022; Gouiric Cavalli *et al.*, 2024; Panzeri *et al.*, 2022) and specialized book chapters and has described several new chondrichthyan and actinopterygian taxa from

Argentina and Antarctica (e.g., Gouiric Cavalli *et al.*, 2024, 2025). Since 2016, she has led a pioneering project on Jurassic fishes from Antarctica, which has broadened the scope of paleoichthyology and contributed to related fields in paleontology and Earth sciences. Soledad is Associate Editor of two paleontological journals (*Ameghiniana* and *Historical Biology*), supervises undergraduate and graduate students, and is an active member of the SCAR Working Group on Geological Heritage and Geoconservation. She also participates in several national and international research projects, covering Paleozoic to Cenozoic fish faunas and contributing to the training of new generations of paleontologists. Beyond research, she is strongly committed to teaching and mentoring at the Faculty of Natural Sciences and Museum, National University of La Plata. She places particular emphasis on guiding and supporting women, migrants, and members of the LGBTQ+ community who wish to pursue careers in paleontology (paleoichthyology). She actively contributes to the preservation of Argentina's paleontological heritage by coordinating and recovering historical archives of the Asociación Paleontológica Argentina and the Vertebrate Paleontology Division.

Emilia Sferco is a young researcher working with fossil fishes and occasionally other vertebrates at the Centro de Investigaciones en Ciencias de la Tierra (CCT Córdoba, Argentina) and the National Research Council of Argentina (CONICET). She has about 26 publications including major contributions on neopterygian phylogenetic relationships (e.g., López-Arbarello and Sferco, 2018) and reinterpretations of some important Argentinian fossil fishes (e.g., Sferco *et al.*, 2015a, b, 2022). Additionally, she has a few outreach contributions promoting paleontological subjects for students and the broad public. As a mother with young kids, she tries to accommodate her research time and other professional duties in the most effective way.



Figure 6. Guillermina Giordano and Carlos René Delgado de Jesús searching for dinosaur bones in the El Cerro del Pueblo Formation, during the Fifth International Meeting on Mesozoic Fishes held in Coahuila state, Mexico in 2010.

4. Analysis of Data and Final Comments

The group of female paleontologists from the Americas studying fossil fishes is small, with less than 25 women, 47% of which are over 50 years old and four have recently passed away (amateur or occasional women working with fossil fishes are not included in this count).

Their social status shows that 60% of the women paleontologists from the Americas were at least once married, and most of these are over 50 years old, with the younger paleontologists preferring to stay alone or have a partner. Only *ca.* 35% of the female paleontologists listed above have children, skewed to the older generations. Thus, the analysis of the social status of our younger colleagues reveals a major social change whose preferences are now to be unmarried and childless.

It is interesting to note that the analysis of the number of publications during the time when children were very young (preschool) and young (kindergarten and beginning of school) reveals different numbers. For instance, among the oldest paleontologists in our group, G. Arratia shows seven publications during the preschool age of her two children (1970-1975); six during kindergarten and beginning of school (1976-1980); and a marked rise in number of publications (15) in the next five years (1981-1985). This was only possible because of the help and assistance of the maternal grandparents (see Nelson, 2010). A comparison with the first author, K. González-Rodríguez reveals a major difference, because she could perform and finish her doctoral studies and dissertation once her daughter was in high school, and consequently her first publications were much later. This is an example of the experience of many women that pursue a professional carrier—they must wait for the children to grow up, because they lack support in this matter. These are two extreme examples of the reality that professional women face in the past and today that has not changed, as shown by the publication record when a mothers' kids are young.

An analysis of the current numbers of qualified specialists on fish paleontology in the Americas reveals that their numbers are low and that there is not a significant difference between sexes. A good measurement is studying the names and numbers of men and women attending “Mesozoic Fishes Meetings” (Figure 7) starting in 1996 in Eichstaett, Germany. The numbers show that some have died, but many are retired with no replacement, regardless of the continent or country. Consistently, there has been a decline in the number of academic positions, which is not related to sex differences, but to political decisions of universities and museums and new trends in scientific pursuits. Thus, the present group of fish paleontologists is *ca.* 40% less than 30 years ago.

Certainly, during the last century, especially starting in the second part, fish paleontology saw an enormous development with outstanding personalities that developed the field in its different branches, including the use of new technologies and techniques (*e.g.*, acid preparation, new specialized microscopes, and others) and new approaches (*e.g.*, cladistic methodology). The research on fossil fishes expanded to a variety of geological periods and clades. Most development was reached under the guidance of male paleontologists, but some of them took special care to educate females, such as J.-P. Lehman in France and D. V. Obruchev in Russia. A similar development was not reached in North America, where only a few females were educated in fish paleontology. Most had highly qualified males as their mentors. A similar situation was observed in Argentina, where most female fish paleontologists also had male doctoral advisors. This is changing, as seen in Canada, Mexico, Argentina and Brazil. Unfortunately, the problems still remain because of a loss of research positions and teaching positions have heavy loads that leave limited time to do research and train the next generation, with many at teaching colleges with no master's or doctoral programs.

Thus, under the current scenario concerning the scarcity of academic positions—either teaching, research or a combination of both—in vertebrate paleontology, especially on fishes, it is unclear whether gender has a role in the selection of candidates, because both males and females are under the same pressure concerning new jobs. As mentioned, significant numbers of female students that were trained in fish paleontology have abandoned this field mainly for economic reasons and found work in a related field, such as fish molecular work, or simply had to find work in completely different areas. In the first case, at least the person and her expertise continue as part of ichthyology, but in the second case, we have lost all the effort in educating someone.

Looking at the career of female paleoichthyologists with children and the responsibility of a family, it is clear that such a normal aspect in human lives has affected their scientific production, and consequently, their evaluations, because, frequently, their publication records do not increase or show a slowdown.

Unfortunately, this is an aspect that may produce enormous frustration for women who have to make a decision that may affect their lives forever. As a result, as the statistics show, many decide not to have children (or postpone them for a later time). This is a decision that is affecting women worldwide with the consequent decline in the number of children. This is a point that should be taken seriously, because once women have shown success in their career, it is very difficult to accept that having a family translates to a negative impact on their career. This point that seems easy to discuss is one that may be fundamental to the future of many women, and the results are showing worldwide.

It is important to emphasize that, in addition to the obstacles mentioned above, there are few museums or research centers dedicated to paleontological studies, most of which are located in Europe, and there are few opportunities to obtain a position dedicated exclusively to research, such as the Natural History Museum in London, the Muséum national



Figure 7. Participants in the 5th International Meeting on Mesozoic Fishes held in the Museo del Desierto, Coahuila state, Mexico in 2010. Note that male fish paleontologists represent the majority as in other meetings, but the number of women participants increased a little.

d'Histoire naturelle in France, the State Museum of Natural History in Stuttgart, the Museum of Natural History in Vienna, and the Natural History Museum of Geneva, to name a few. Most of the positions held by the fish paleontologist women mentioned here are at state universities, where a large percentage of their time is spent teaching and performing administrative tasks, leaving them very little time for research and training new specialists. Add to that childcare and household responsibilities, and the production of scientific articles and attendance at scientific meetings is reduced.

The abbreviated information presented above shows that despite few women having worked in fish paleontology, they have played an important role in the development and current level of knowledge of paleontology of fishes and ichthyology in general, as their publication records demonstrate.

Contributions of authors

The three authors contributed equally to the conceptualization, investigation, preparation, and presentation of the published work. The three authors contributed equally to the conceptualization, investigation, preparation, and presentation of the published work. H.-P. Schultze was especially helpful in sharing his knowledge of European and Asian women colleagues' publication records.

Conflicts of interest

The authors declare that there are no conflicts of interest related to this article.

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