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A preliminary biography of Armand de Ricqlès (1938–), the great synthesizer of bone histology

Une biographie préliminaire d'Armand de Ricqlès (1938–), l'encyclopédiste de l'histologie osseuse

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ABSTRACT

Armand de Ricqlès has had a long, successful career. From his start as an Assistant in the University of Paris in 1961, he defended his doctoral thesis in 1963, became Maître-Assistant (Assistant Professor) in 1970 (tenured 1971), defended his "doctorat d'état" (habilitation thesis) in 1973, was nominated Professor in the University Paris 7, was promoted to first class (Full Professor) in 1987, and was finally nominated to the prestigious chair "Biologie Historique et Évolutionnisme" (Historical and Evolutionary Biology) of the Collège de France in 1996. He lectured on a wide range of topics, especially in comparative and evolutionary biology, and assumed important administrative responsibilities, including responsibility of various master's programs, leadership of the team "Formations squelettiques" (1973–2002; till Professor Jacques Castanet took over leadership of the team), involvement in various committees, and in organizing scientific meetings. He served on several editorial committees and was co-editor of the "Annales des Sciences Naturelles", as well as co-editor-in-chief of the "Comptes Rendus Palevol". His scientific research always emphasized bone histology, especially paleohistology, but he also made contributions to systematic paleontology, phylogenetics, history of paleontology, and biological nomenclature, in decreasing order of importance. He has so far published over 100 scientific papers and 120 semi-popular papers.

Mots clés :
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RÉSUMÉ

La longue carrière d'Armand de Ricqlès a été couronnée de succès. Nommé Assistant à l'Université de Paris dès 1961, il soutint sa thèse de doctorat de 3e cycle en 1963, fut promu Maître-Assistant en 1970 (titulaire en 1971), soutint son doctorat d'état en 1973, fut nommé Professeur à l'Université Paris 7, puis promu en première classe en 1987. Il obtint finalement la prestigieuse chaire de Biologie Historique et Évolutionnisme du Collège de France en 1996. Il enseigna de nombreux sujets, spécialement en biologie comparative et évolutive ; il accepta d'importantes responsabilités administratives, incluant la direction de divers DEA et de l'équipe « Formations squelettiques » (1973–2002, jusqu'à ce que le Professeur Jacques Castanet lui succède dans cette fonction). Il participa à divers comités, qu'il présida souvent, et organisa plusieurs congrès scientifiques. Il est membre de plusieurs comités de lecture

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et fut co-rédacteur des « Annales des Sciences Naturelles », ainsi que l'un des quadre rédacteurs en chef des « Comptes Rendus Palevol ». Sa recherche scientifique porte surtout sur l'histologie osseuse des tétrapodes et, plus particulièrement, sur la paléohistologie, mais il publia également quelques articles en paléontologie systématique, en phylogénétique, en histoire de la paléontologie, et en nomenclature biologique, en ordre d'importance décroissante. Il a pour l'instant publié plus de 100 articles scientifiques et 120 articles de vulgarisation.

1. Introduction

It has been said that many scientists have had a positive influence in their field in the first half of their career, and a rather negative influence in the second half of their career (through an excessively conservative attitude that hampers acceptance of new hypotheses and methods). As this biography will attempt to show, the career of Armand de Ricqlès provides a nice counter-example; Armand remained a leading figure in the field of vertebrate paleohistology, paleobiology, and paleoecology, and fostered the development of new ideas and methods (several of which he incorporated into his work) until his official retirement in 2010. His open-mindedness, thorough knowledge of bone histology and microanatomy, and constant support of various initiatives taken by members of the team "Formations squelettiques" played a significant role in the development of that team for more than 35 years (1973–2008). This biography is necessarily preliminary to the extent that Armand will no doubt remain active as Emeritus Professor of the Collège de France for many more years. Nevertheless, it seems appropriate to include a summary of Armand's career in the Festschrift that celebrates his retirement. Even though Armand is probably best known for his work on paleohistology focusing on growth dynamics and thermal physiology (de Ricqlès et al., 2006), this topic will be evoked only briefly here because it is emphasized in another contribution in this volume (Padian, 2011).

1.1. Youth and studies

Armand de Ricqlès was born on December 23, 1938 in Bruxelles (Belgium). He had a broad range of interests in natural sciences, and these led him to study biology at the Sorbonne, in Paris, where he obtained a "Licence" in Natural Sciences from the University of Paris in 1960. The "Licence" is roughly analogous to a BSc in America (no French degree or academic position, especially at that time, has strict equivalents in North America and in many cases, in other European countries). The teachings of Marcel Prenant, Charles Devillers and Yves François strengthened his wish to study vertebrate evolution and to focus on amphibians and reptiles. Simultaneously he took courses on other topics, such as general biology (by Grassé and Panigel), botany (by Eichorn, Plantefol and Chadefaud), geology (by Glangeaud, Durand-Delga, and Caire), animal physiology (by Jost, Morel, and Buser), and plant physiology (by Chouard and Moïse). These courses must have been excellent because Armand subsequently published semi-popular papers on topics fairly remote from his primary research interests, such as botany and insects (especially dragonflies and damselfishes) (de Ricqlès, 1970; de Ricqlès and Aguesse, 1968). However, his colleagues from the earliest days have always regarded him as a polymath, interested in all fields and able to answer the most obscure questions.

Armand started working as an "Assistant" for the same university in 1961, taking advantage of the "baby boom" that allowed (at that time) good academics to get on tenure-track positions well before obtaining a thesis. Simultaneously, he prepared his DEA (Diplôme d'Études Approfondies; analogous to a Master's), quickly followed by a doctoral thesis ("Doctorat de troisième cycle", similar to a PhD) in the Laboratory of Comparative Anatomy at the Sorbonne. As part of the coursework for these degrees, he took courses on histology and cytology, including some courses by René Couteaux on cell biology and ultrastructure, that gave him his first advanced technical laboratory experience. His thesis was supervised by Marcel Prenant and focused on histology, especially on long bone morphogenesis of *Pleurodeles*, the topic of his very first scientific paper (see below). His interests in large-scale vertebrate evolution quickly led him to the conclusion that studying only extant forms was insufficient to get a global perspective. This logically led him to take vertebrate paleontology courses given by Jean Anthony, Robert Hofstetter, Jean-Pierre Lehman, and Jean Piveteau. The thesis defense took place in 1963; the jury included M. Prenant, R. Couteaux and Y. François. In the next few years, Armand did his military service (1965–66) and was promoted to the rank of "Maître-Assistant stagiaire" (analogous to Assistant Professor) in 1970. As is typical of the French system, he was tenured the following year (1971). The French tenure-track is not meant to ensure that a scientist can remain productive while working autonomously and teach simultaneously for several years; instead, it is aimed at ensuring that the new Faculty member works in a satisfactory manner in his new environment. By then, Armand had all the basic training that he needed to become a leader in vertebrate paleohistology.

Armand must have found the team "Formations squelettiques" (then led by Y. François) a very good working environment because he remained in that team for most of his career, until the endless bureaucratic quarrel between the presidency of the UPMC (Université Pierre et Marie Curie) and of the Muséum National d'Histoire Naturelle led to its dismantling on January 1, 2009. Ever since his first doctoral thesis defense, Armand had been preparing a second, larger thesis called the "Doctorat d'état" (that he defended in 1973), that was required in France to supervise doctoral students or to advance in an academic career (to the rank of Professor, equivalent to Associate or Full

Fig. 1. Armand presenting his habilitation thesis (1973). In the background, several pictures of sections of Paleozoic and Triassic stegocephalian bones are visible.
Fig. 1. Armand présentant sa thèse d'habilitation (1973). Au fond, on remarque plusieurs photos de coupes d'os de stégocéphales du Paléozoïque et du Trias.

Fig. 2. Thesis committee of Armand's habilitation thesis (1973). From left to right: Jean-Pierre Lehman, Jean Piveteau, Charles Devillers, and Yves François.
Fig. 2. Jury de thèse d'habilitation d'Armand (1973). De gauche à droite : Jean-Pierre Lehman, Jean Piveteau, Charles Devillers et Yves François.

Professor in the North American system; the "Doctorat d'état" no longer exists, but it has been replaced by the "Habilitation", which is still required for similar academic advancement in France). His choice of paleohistology as the central topic of his habilitation reflected his wish to study vertebrate paleontology, biology and evolution, and his wish to take advantage of his expertise in bone histology. Thus, for Armand, paleohistology constituted a means of inferring various life history, physiological, and ecological attributes of early tetrapods, rather than a way to identify fossils and infer their phylogeny, as shown by the focus of paleohistological research on primitively aquatic Paleozoic vertebrates (Denison, 1951; Ørvig, 1966).

Thus, Armand was a paleobiologist right from the start of his career, well before there was a widespread interest in this field, as shown by the subsequent launching (in 1975) of the journal *Paleobiology*. He was inspired by pioneers in that field, such as Alfred Sherwood Romer and Jim Hopson (paleobiology), Donald Enlow and Rodolfo Amprino (functionally-oriented bone histology), Walter Gross, Tor Ørvig, and Beverly Halstead (bone paleohistology), and by the teachings of Charles Devillers, who was both an embryologist and a paleontologist. His habilitation thesis formed the basis for many of Armand's early contributions in the field of comparative and functional bone histology and paleohistology (Fig. 1). The defense committee of the "Doctorat d'état" was composed of the French leaders in the field of bone histology and vertebrate paleontology and evolution, namely J. Piveteau, C. Devillers, J.-P. Lehman, and Y. François (Fig. 2).

1.2. Later career

Armand continued teaching at the University Paris 7 (this is one of the several universities into which the former *Université de Paris* was split following the famous student protests of May 1968) as Maître de Conférences until he was named Professor in the same university on January 1, 1983 to succeed to Professor Yves François, who had retired (Meunier, 2000). He was quickly promoted (January 1, 1987) to First Class Professor (equivalent to Full Professor in North America) in the same university, where he remained until 1995, when he was nominated to the prestigious chair "Biologie Historique et Évolutionnisme" (Historical and Evolutionary Biology) of the Collège de France, an institution that was established by the king of France François I in the 16th century. Incidentally, that nomination was important for me too because I first came to France to temporarily replace Armand in teaching the courses at the University of Paris 7 that his duties at the Collège de France made it impossible for him to fulfill.

Armand's teaching responsibilities were as diversified as his research interests. As early as 1962, as Assistant, he handled laboratory tutorials. He taught taxonomy-oriented zoology and botany short field courses at the Roscoff field station (Brittany), in Fontainebleau, and Franchard (Île-de-France). He taught a variety of courses at Paris 7: metazoan evolution (focusing on arthropods), vertebrate comparative anatomy, general paleontology, principles of phylogenetics, histology, and a bit of evolutionary theory and of history of zoology. In addition, he gave many public seminars in various symposia or as guest speaker. Finally, at the Collège de France, he gave a different course every year, on evolutionary and paleontological topics. Each year, the course included a symposium that involved French and other guest speakers; these have included, to name only a few who came to France for this purpose, Dennis Carter (Stanford, California), Kevin Padian (University of California, Berkeley), Rainer Schoch (Staatliches Museum für Naturkunde, Stuttgart, Germany), and Tim Smithson (Cambridge Regional College, England). The French speakers are too numerous to name; just in the last year (2008–2009), the symposium, entitled "150 ans après l'Origine des espèces : du darwinisme de Darwin à l'évolutionnisme contemporain" (150 years after the Origin

of species: from Darwin's Darwinism to contemporary evolutionary theory) involved Jean Dutch (UPMC), Jean Gayon (University Paris 1), Guillaume Lecointre (MNHN), Hervé Le Guyader (UMPC), Annie Mamecier (National Ministry of Education), Pascal Tassy (MNHN), and Michel Veuille (EPHE: École Pratique des Hautes Études).

Armand's teaching responsibilities also included defining the content of various courses and programs (mostly from the third to fifth years). As President of the UPMC Scientific Council, he fought the strong tendency that pushed many biology departments (especially in France) to completely abandon morphology to concentrate solely on subjects deemed more "modern," such as molecular biology, genetics, and physiology. He was in charge of at least three Master's programs (DEA) in the field of evolutionary biology, systematics, and paleontology.

Another form of teaching at which Armand has excelled is the publication of semi-popular papers. He has so far published at least 120 of them (Laurin, this issue), and will no doubt publish more in the coming years. He started early in his career because his first was published in 1967, when he was less than 30 years old. He published regularly in various French semi-popular magazines, such as *La Recherche*, *Pour la Science* (the French edition of *Scientific American*), the *Encyclopedia Universalis*, and various other magazines and books. The range of topics covered in these papers was even broader than Armand's research interests because they included papers on history of life and genetics, evolutionary theory, and the Cambrian evolutionary radiation.

Armand was co-director (along with Yves François) of the team "Formations squelettiques" as early as 1973, and became its sole leader in 1982. That team included several scientists interested in bone histology (not necessarily for all their careers): Vivian de Buffrénil, Jacques Castanet, Jorge Cubo, Hélène Francillon-Vieillot, François Meunier, Alexandra Quilhac, Jean-Yves Sire, Louise Zylberberg, and myself. In the 1990s, Armand attempted to integrate a molecular biologist (Marc Girondot) to add another approach to the study of vertebrate mineralized tissues. The subsequent nomination of Laure Bonnaud (a molecular phylogeneticist) to our team strengthened this initiative, at least in the short-term. Ultimately, however, that attempt was not altogether successful, and both molecular biologists left the team, either when an opportunity for a promotion arose (Marc Girondot), or to be in an environment where a greater diversity of molecular studies could be better supported (Laure Bonnaud).

Armand also participated in the organization of several scientific meetings, either as the head of the organizing committee, as the co-organizer, or as a member of the organizing committee. These include, in addition to the first ISPN meeting (Section 3.2), the following. As chief organizer: "La croissance périodique" (periodic growth), a symposium of the Société Zoologique de France (1979); "Formes panchroniques et fossiles vivants" (Panchronic forms and living fossils), a symposium in the annual meeting of the Société Zoologique de France organized to celebrate the centenary of the death of Charles Darwin (1982); "Table ronde contrat européen Erasmus sur l'anatomie fonctionnelle" (Symposium on the European Erasmus contract on functional anatomy; 1992). As co-organizer: "Classification et phylogenèse" (Classification and phylogeny), symposium of the Société Zoologique de France (1977); "Premier symposium international sur les écosystèmes continentaux du Mésozoïque" (First international symposium on Mesozoic continental ecosystems; 1978); "Second international symposium on the genus *Triturus*" (1986); "Table ronde autour du livre de Stephen Jay Gould *La vie est belle*" (Symposium on Stephen Jay Gould's book Wonderful Life: *The Burgess Shale and the Nature of History*; 1991). As member of the organizing committee: "Ontogenèse et évolution" (Ontogeny and evolution; 1986); First World Herpetological Congress (1989).

Armand took on several editorial duties, especially of French journals. He served on the editorial committee of the "Annales de Paléontologie", a journal in which he published at least 26 papers (Laurin, 2011, this issue), of "L'Année Biologique", of the "Bulletin de la Société Herpétologique de France", and of the Belgian Journal of Zoology. He was co-editor of the "Annales des Sciences Naturelles" from 1986 and to 2000, when that journal ceased publication (de Ricqlès, 2000a). Most importantly, he has been one of the four co-editors-in-chief (along with Philippe Taquet, Yves Coppens, and Kevin Padian) of the "Comptes Rendus Palevol" of the Académie des Sciences de Paris since that journal appeared in 2002, and has published about one paper per year in that journal (Laurin, 2011).

2. Bone histology

2.1. Histology, bone microanatomy, and lifestyle

Although most of Armand's later works focused on paleohistology (Laurin, this issue), his first works on bone histology focused on extant taxa. His very first paper (published in two parts), derived from his doctoral thesis, focused on morphogenesis of the urodele *Pleurodeles waltlii* (de Ricqlès, 1964; de Ricqlès, 1965). In that paper, Armand noted that the medullary cells seem to have an exogenous origin, rather than deriving from the chondroblasts or chondrocytes, thus refuting an earlier hypothesis.

In the same paper, Armand also noted that endochondral ossification occurs late in *P. waltlii*, and attributed this to its aquatic lifestyle. This was only the first observation of a long series that would pave the way for much more detailed studies on the relationship between bone microanatomy and lifestyle (aquatic to terrestrial). His Habilitation thesis included what was probably the most thorough treatment of this question at the time, at least on extinct vertebrates. Thus, Armand used bone microanatomy to infer the lifestyle of many early vertebrates, such as Paleozoic stegocephalians (de Ricqlès, 1981) and amniotes (de Ricqlès, 1974). These works triggered many later investigations about the relationship between bone microanatomy and lifestyle in extant vertebrates using more quantitative techniques by various scientists (Fish and Stein, 1991; Leclair et al., 1993; Stein, 1989; Wall, 1983), including several by his former doctoral student Vivian de Buffrénil (de Buffrénil and Schoevaert, 1989; de Buffrénil et al., 1986; Wiffen et al., 1995), myself (Laurin et al., 2006; Steyer et al., 2004), and our own stu-

dents (Canoville and Laurin, 2009; Houssaye, 2009; Laurin et al., 2009). Similarly, paleobiological investigations into the lifestyle of various early vertebrates were also undertaken by several other labs (Green et al., 2010; Ray and Chinsamy, 2004; Ray et al., 2005) or by Armand's former students and collaborators (de Buffrénil et al., 1990a; de Buffrénil et al., 1990b; de Ricqlès and de Buffrénil, 1995), as well as mixed studies that included both investigations on extant and extinct taxa, that can provide more rigorous inferences (Canoville and Laurin, 2010; Kriloff et al., 2008) or document changes in bone microanatomy following habitat changes (de Buffrénil et al., 2010). All these works, and many others that are not evoked here for lack of space, were at least to an extent inspired by Armand's pioneering efforts.

2.2. Nomenclature of bone tissues

Armand proposed a very detailed classification of bone tissues (de Ricqlès, 1975, 1976, 1977a, 1977b, 1978a, 1978b) and standardized nomenclature in that field, much like Linnaeus' great influence on biological nomenclature in the 18th century. The parallel can be drawn further because Armand's treatment of bone classification and nomenclature shows several similarities with taxonomic monographs. Thus, his papers provide a diagnosis, they describe the mode of formation, and provide synonymy (with authorship of each synonym) and subdivisions of each tissue type. The nomenclature mostly reflected the density and orientation of vascularization, the orientation of collagen fibers, and the density of secondary osteons. This provided an invaluable reference to decrypt the histological literature because many names had been given to various tissue types. For instance, what Armand called "fibrolamellar bone with primary longitudinal and circular osteons" (de Ricqlès, 1975) was called "in toto concentrico Knochen" by Gebhardt (Gebhardt, 1901), "laminare bone" by Meyburg (Meyburg, 1904), "Type II" by Foote (Foote, 1916), and "laminaren Periostknochen" by Gross (Gross, 1934). Clearly, as in taxonomy, communication is facilitated by a standardized nomenclature (de Queiroz and Gauthier, 1994; Laurin, 2008). The widespread acceptance of Armand's nomenclature of bone tissues (Botha and Chinsamy, 2005; Chinsamy and Tumarkin-Deratzian, 2009; Green et al., 2010; Ray et al., 2005; Scheyer et al., 2010; Witzmann, in press) and the fact that it was based on a thorough survey of a large body of literature may justify calling him "the great synthesizer of bone histology".

2.3. Histology and physiology of extant taxa

An important part of Armand's habilitation thesis, published in several parts (de Ricqlès, 1975, 1976, 1977a, 1977b, 1978a, 1978b), was a study of the functional significance of bone tissues. This concerned especially the relationship between bone tissue architecture (of vascularization, of collagen fiber orientation, etc.) and deposition rate. That work included a thorough, critical review of the literature, such as the important papers by Enlow and Brown (1956, 1957, 1958) and work by Amprino that

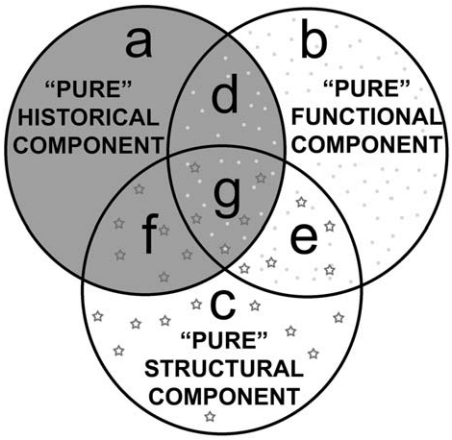

Fig. 3. Three-dimensional model, "Cubo's cube", attributing the explained variance of a dependent character to three partitions.
Fig. 3. Modèle tridimensionnel du « Cube de Cubo » attribuant la variance d'un caractère dépendant à trois facteurs explicatifs.
Modified from/*Adapté de* (Cubo et al., 2008).

established a link between bone tissue structure and deposition rate, a link now known as Amprino's rule (Amprino, 1947). It also included mostly qualitative, but numerous observations on original bone sections. That work laid the foundation for more quantitative studies on this topic (de Margerie et al., 2002, 2004) that largely confirmed, with a few exceptions, Armand's findings. For instance, quantitative studies confirmed that avascular bone is deposited more slowly than vascular bone (de Margerie et al., 2002), and radial bone is deposited faster than laminar bone (de Margerie et al., 2004).

Armand collaborated with younger scientists whom he helped to train in this field in recent quantitative studies. In some of these studies evoked above (de Margerie et al., 2002; de Margerie et al., 2004), vital staining was used, as Meunier and Pascal (1981), Castanet and Naulleau (1985), and Castanet et al. (2000) had done earlier, to mark bone tissues at various dates to more rigorously and precisely determine how much time had elapsed between the deposition of various layers. In another study (Cubo et al., 2008), a new three-dimensional model was developed to partition variance of a dependent character (here, bone growth rate) into three components. In this case, these components were historical (phylogenetic), functional (mass-corrected resting metabolic rate), and structural (relative perimeter of growth, measured as the ratio between the sum of osteonal and peripheral accretional surfaces and the sole peripheral accretional surface). Although that model can be represented in various ways, and it was introduced with a series of partly overlapping circles (Fig. 3), such a three-dimensional model can also be conceptualized as a cubic one, and I cannot resist calling it "Cubo's cube", in honor of the first author of the paper that introduced it. That name is fitting not only because of the authorship, but also because there is an amusing (but not statistically significant!) parallel between the careers of Jorge Cubo and Pablo Picasso, the founder of cubism: both were born in Malaga, worked for some years in Barcelona, and then moved on to Paris

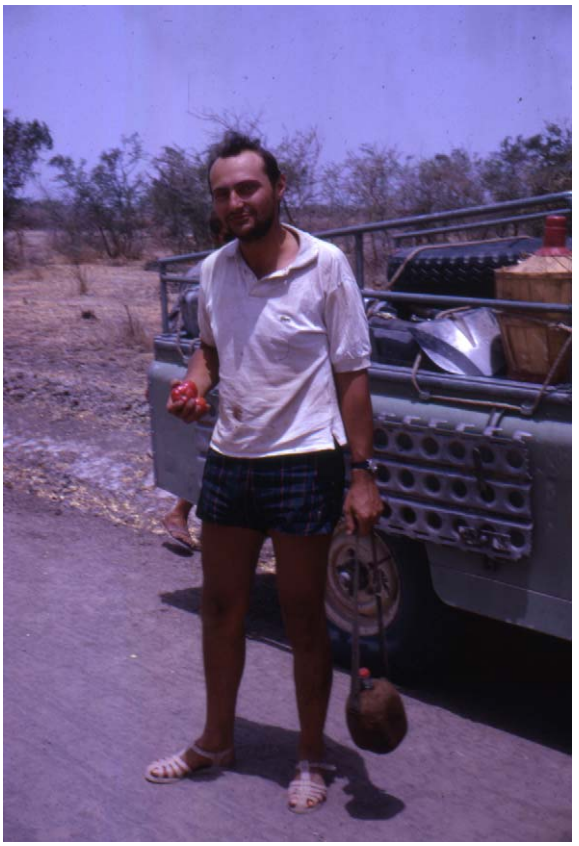

Fig. 4. Armand in Nigeria, on his way to Niger, 1967 field trip to Permo-Triassic localities.
Fig. 4. Armand au Nigeria, en chemin vers le Niger. Expédition de 1967 vers diverses localités datant du Permien et du Trias.

(where Picasso spent the last part of his career; the same is likely to happen to Cubo because he is already Professor at the UPMC).

3. Other research interests

3.1. Systematic paleontology

Armand's interests in vertebrate paleontology led him to participate in several field trips. In 1967, he went with Raymond Desparmet and Philippe Taquet to Niger to prospect Permian and Triassic localities (Fig. 4). There, the team discovered fossils in various strata, including the Permian captorhinid *Moradisaurus grandis* that Armand later described with P. Taquet (de Ricqlès and Taquet, 1982).

In 1975, Armand accompanied Bernard Battail and Jean-Michel Dutuit (both from the Natural History Museum, Paris) to prospect Permo-Triassic strata in the Moroccan Atlas. They discovered new fossiliferous sites that yielded temnospondyls (Dutuit, 1972, 1976b), diplocaulid nectrideans (Dutuit, 1976a, 1988a), therapsids (Dutuit, 1988b, 1989a, b), and phytosaurs and brought back eight tons of fossils still in their matrix. Although Armand did not describe the taxa discovered in that field trip, he participated in a histological and skeletochronological study (Steyer et al., 2004) of one of the temnospondyls, *Dutuitosaurus ouazzoui,* initially described by J.-M. Dutuit under the name *Metoposaurus ouazzoui* (Dutuit, 1976b).

Armand prospected in the Permian of Oklahoma, at the famous Dolese Brothers Quarry, with John Bolt (in 1980 and 1981). Armand then used the rich collections of the Field museum to study tooth replacement in *Captorhinus* through numerous sections in various planes, a type of study that could be performed, before the advent of CT-scanners, only on taxa represented by abundant material (de Ricqlès and Bolt, 1983).

In his last field trip, Armand accompanied Anusuya Chinsamy, who later also became a famous paleohistologist, in the Permo-Triassic Karoo basin. There, they collected various stegocephalians, including some therapsids and archosauriforms. During that trip, Armand also had the opportunity to borrow material from the rich Permo-Triassic collections of the museums of Cape Town and Johannesburg.

3.2. Phylogenetics, taxonomy and nomenclature

Some of Armand's works in paleontology had a strong phylogenetic component. Thus, two of his papers include some of the first cladograms of Paleozoic stegocephalians ever to be published (de Ricqlès, 1984; de Ricqlès and Taquet, 1982). These papers included a fairly detailed phylogeny of captorhinids. The supporting datasets were derived from a paper by Eugene Gaffney and Malcolm McKenna (Gaffney and Mc Kenna, 1979) that contains what may be the earliest cladogram of any early stegocephalian taxon (in this case, Captorhinidae). However, at that time, cladistics had not yet become the default, nearly compulsory method in phylogenetic inference that it has since become (at least for morphologists). I remember, from my post-doc days (1994–1996) in Berkeley (California), seeing the following warning near the door of a laboratory: "Warning, dangerous cladists, free radicals". In the early 1980s, systematics was deeply divided between proponents of numerical taxonomy (phenetics) and cladistics (the "new systematics" had already become old and even though it still had its adepts, especially among morphologists, it was clearly on its way out, squeezed between the two other, more "modern", quantitative and a priori objective methods). This episode was admirably reviewed by Joseph Felsenstein (Felsenstein, 2001), who mentions (p. 466), among other anecdotes, that at the Numerical Taxonomy meeting at Harvard, in 1979: "The two camps sat on opposite sides of the auditorium (cladists on the right, others on the left) and the atmosphere was totally partisan. When a speaker from one side made a point, the other groaned, while adherents murmured approval". In light of this, Armand's early adoption of cladistics may be seen as visionary.

Armand was perhaps even bolder in supporting the development of phylogenetic nomenclature. Back in 2003, I was planning the First International Phylogenetic Nomenclature Meeting with the help of a small committee that included, among a few other members, Armand. At that time, some of our French colleagues (including some at the

Muséum) were not thrilled that the Museum had agreed to host that meeting. Indeed, the development of phylogenetic nomenclature triggered a vivid debate between its proponents and systematists who want to retain rank-based nomenclature (Laurin, 2008). Some of the latter have even considered phylogenetic nomenclature and the PhyloCode "at best as a mistake and at worst as a criminal operation against the study of biodiversity" (Dubois, 2005) or "pure folly" (Carpenter, 2003). Yet, Armand supported this initiative as best he could, helped to publicize the meeting (Laurin and de Ricqlès, 2004; Laurin et al., 2003), and obtained a grant from the Fondation Hugot that enabled us to organize the banquet in the historic restaurant "Le Train Bleu" and to provide gastronomic coffee break food such as fresh pastries, cheese, cold cuts, and wine. My former thesis advisor, Robert R. Reisz, who is certainly a connaisseur of good food, even called this event "The best-tasting meeting I ever attended" (personal communication from Reisz at the meeting). The meeting can be considered a success because it launched an international society (Laurin and Cantino, 2004; Laurin and de Ricqlès, 2004), the ISPN (International Society for Phylogenetic Nomenclature), that supervises the development of the PhyloCode (Cantino and de Queiroz, 2010). That society has met twice more since then, in 2006 (Laurin and Cantino, 2007) and 2008 (Laurin and Bryant, 2009) and has fostered developments in phylogenetic nomenclature. Armand integrated principles of phylogenetic nomenclature in his scientific papers and activity reports for the Collège de France from the late 1990s onwards (de Ricqlès, 2000b).

3.3. History of paleontology and scientific policies

Armand does not consider himself a historian of sciences, but he has long been interested in that topic. He published biographies of Jean Piveteau and Charles L. Camp. In his biography of Piveteau (de Ricqlès, 1991), he focused on Piveteau's influence on the Parisian school of paleontology. He argued that his influence resulted in increased international communication, the introduction of new technologies, and closer ties with biology (much of the previous Parisian paleontology was more geologically and stratigraphically oriented). Piveteau required technical and methodological rigor of his collaborators, but left them complete intellectual freedom; there was no established dogma that could not be refuted, provided that the argument was based on factually correct data and logical reasoning. Of course, as in most other paleontological communities, much of that research rested on detailed anatomical descriptions.

But Armand did not use his historical and comparative perspective only to discuss the past, but also to enlighten us about the present. Thus, in an admirable, very lucid short note "Quelques réflexions sur la recherche fondamentale en France" (de Ricqlès, 2007), Armand vividly highlighted various problems that many scientific communities in the world may face to an extent, but that seem especially acute in France. These include an excessive administrative burden placed on scientists, who spend far too much time writing reports on their activity, that of their own team, and of their UMR ("Unité Mixte de Recherche"; normally formed by at least a few teams); these reports then have to show how all this activity is coherent with a larger group and with research objectives that have been dictated from above, by various layers of ministries, agencies, and institutions. These reports, as well as grant requests are then evaluated by various agencies, too often only by French scientists, so a great deal of time is wasted in redundant evaluations that are not of optimal quality. The notoriously heavy French bureaucracy greatly hampers scientific progress by limiting initiative of scientists or by forcing them to change their research focus to follow various fashions that are dictated by institutions.

4. Conclusion

In his long career, Armand developed a diversity of research topics without paying too much attention to what was fashionable. He had fairly heavy teaching and administrative duties, and published about 120 semi-popular papers, mostly in French magazines that seldom get cited in the scientific literature. Yet, according to a quick citation search in the ISI databanks on 27-2-2010, his 104 scientific papers (original research papers, reviews, or book chapters) generated over 1575 citations to his work (this includes citations from some papers to which he was not first author and that were not directly indexed by the ISI; for these, I searched under the first author under a cited reference work, but I could not do that for every paper because of time constraints). Thus, his diversity of activities did not prevent (and perhaps even contributed to) his nomination to the Collège de France, a sure sign of success. Scientists who are starting their career, and who face unprecedented pressure to work on high-priority topics and publish fashionable papers in prestigious journals (read "journals with a high impact factor") should keep this in mind. The long-term value of work thus focused is dubious; I do not think that too many geniuses worked on such previously identified topics (and it would be extraordinary if politicians and their handful of advisors had the ability to correctly identify them). As the saying goes, "the lamp bulb was not invented by trying to improve the candle". Imagination and technical rigor, as displayed by Armand throughout his career, play a far greater role in determining the quality of research than scientific fashion.

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