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Current trends in Paleontology and Evolution

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Paleoart: term and conditions (a survey among paleontologists)

Paleoarte: término y condiciones (un sondeo entre los paleontólogos)

Marco Ansón[1]*, Manuel Hernández Fernández[2,3] y Pedro A. Saura Ramos[1]

Paleoarte es un término utilizado ampliamente en el mundo paleontológico. Este término puede encontrarse en diferentes medios, empleándose para referirse a diferentes manifestaciones artísticas de temática paleontológica. El paleoarte tiene una larga historia y ha ayudado a que la paleontología se convierta en una de las ciencias más populares. La producción de estas obras implica que los paleoartistas deben poseer un elevado nivel de habilidad artística y conocimientos paleontológicos. Por todo su valor científico, artístico y cultural, el paleoarte y los paleoartistas deben ser reconocidos y valorados tanto en el campo de la paleontología como en las bellas artes. En esta situación el paleoarte necesita una definición clara que lo distinga de otras representaciones artísticas. Con ese objetivo en mente, hemos realizado una consulta a un conjunto de paleontólogos, la cual nos ha ayudado a perfilar tal definición. Se pueden considerar paleoarte todas aquellas manifestaciones artísticas originales que pretenden reconstruir o representar formas de vida prehistóricas acordes a los conocimientos y evidencias científicas existentes en el momento de crear la obra.

Palabras clave: Paleontología, Arte, Reconstrucción, Teoría artística, cultura

Paleoart is a widely used term in the paleontological world. This word can be found in different media, used in relation to different kinds of artistic manifestations of paleontological theme. Paleoart has a long history and has helped paleontology to became one of the most popular sciences. The production of this artwork means that paleoartists must have high skills in both disciplines, arts and paleontology. Due to its scientist, artistic and cultural significance, paleoart and paleoartists must be recognized and valued in both paleontology and fine arts. In this situation paleoart needs a clear definition that distinguishes it from other artistic representations. Taking this into account, we have consulted to a series of paleontologists, and this survey has allowed us to outline such a definition. All the original artistic manifestations that pretend to reconstruct o depict prehistoric life according to the current knowledge and scientific evidence at the moment of creating the artwork can be considered paleoart.

Keywords: Paleontology, Art, Reconstruction, Art theory, culture

1. Introduction

Paleontology is a science that generates social attraction like few other disciplines can do (Witton et al. 2014). It is impossible to deny its media impact and the support art has given to the growth of paleontology as a living science, always at the vanguard, always correcting ideas and providing new releases, in what it is now an indivisible relationship. This interaction involves social, cultural and economic aspects, since paleontology has become an educational, cultural, touristic and economic resource. This interest and potential signifies a substantial financial source with a multimillionaire industry, centered in the editorial system but extended to many other areas, which continuously produce all sorts of representations with esthetic origins in paleoart.

The term paleoart was introduced in the late 1980s by the natural history illustrator Mark Hallett (1986), who used it as an informal word to describe his own work. Paleoart became a catchy synonym to paleontological sculptures and paintings. Since then, this term has been widely used both in academic and informal media to refer to any artistic representation of a prehistoric organism or environment. The scientific nature of paleoart and its integrative educative potential provide the

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basic tools to understand the past through this kind of artistic representations. That is why this word can be found on different publications, books or exhibitions; great artists that portrait organisms from the past are called paleoartists; there are books about paleoart and their creators, even institutional paleoart contests and awards.

It is undeniable the impact that fossils have had along the history of human cultures (Oakley, 1975; Mayor, 2000; Sarris and Narváez Padilla, 2009). Since we are a visual-oriented species (Elgin, 2003), we need to be able to visualize and picture in our minds the face and the body of those past creatures and worlds that fascinate us. For this reason human beings are constantly searching for answers to the enigmas of nature. From the first contacts with different fossils we have tried to give an explanation, generating a visual model of the living animal. These interpretations would create mythological icons like the griffon (Mayor, 2000) and the cyclops (Abel, 1914). Therefore, in order to understand paleoart it is necessary to have a look to the historic restorations of the old masters.

The origin of paleoart lies within the origin of paleontology as science. Since the very first moment, modern paleontologists needed to visualize the prehistorical bestiary that fossils represented; and the first attempt to make a correct reconstruction of a fossil vertebrate came from George Cuvier (Rudwick, 1992). The success of paleoart was consolidated by Henry de la Beche, who created *Duria Antiquior* in 1830, the first reconstruction of a paleoenvironment and the organisms that lived there (Rudwick, 2008). In 1854, paleoart and vertebrate paleontology made their entrance in popular culture through the big-sized sculptures made by Benjamin Waterhouse Hawkins for the exhibition at the Crystal Palace in Sydenham. From this moment on, an industry derived from these paleontological representations was generated, full of consumers beyond the publishing and academic media.

The quantum leap within paleoart discipline occurred in the late nineteenth century with the art of the artist Charles R. Knight, who understood fossils in terms of compared anatomy being able to create a fine reconstruction of the animal appearance. He also developed the methodology of reconstruction from inside to outside, a sequential series of steps from the bones to the external appearance of the animal (Antón, 2007). Previous paleoartists were not able to represent correctly an extant animal, much less an extinct one. Throughout the twentieth century some other artists appeared on scene and became great masters of paleoart, such as Rudolph Zallinger and Zdeněk Burian. The production of great paleoart implied seeking for advice and collaboration from scientists in such a way that this artwork reflects the scientific knowledge at the moment of its creation. As a consequence paleoart representations have been changing throughout paleontology history as a science, adapting itself to new discoveries.

Among modern paleoartists, paleontological research for an accurate reconstruction has become a substantial part of their work. Among them, Jay Matternes is a key figure as he pictured the steps of the sequential methodology of reconstruction, working as a visual display to justify the reconstruction (Bates, 1964). In this sense, some artists had published methodologies and instructions for reconstructing the appearance of fossil fauna (Scott, 1913; Paul, 1987; Antón and Sánchez, 2004). Other artists, among which Gregory S. Paul and Mauricio Antón stand out, have not just created images defining the species they represent but have also made multiple scientific publications focusing on their reconstruction (Paul, 1988a; Olshevsky, 1991; Antón et al. 1998, 2009; Antón, 2007; Pérez González et al. 2009; Ansón and Hernández Fernández, 2013), even suggesting new hypothesis, like the defensive behavior of *Triceratops* pictured by Mark Hallett (Wexo, 1987), or anticipating scientific knowledge that can be subsequently verified by fossil evidence, as the predatory behaviour of *Tyrannosaurus* on *Triceratops* (Paul, 1988b; Erickson and Olson, 1996).

Nevertheless, in spite of the success of the term, today there is a lack of a shared definition of paleoart, since no one has suggested one that can be universally accepted or valid. Paleoart as an art itself must be separated from other media related to prehistoric and paleontological themes. In this context, Allen Debus and Diane Debus use the term paleoimagery, which addresses evolving ideas about prehistoric animal imagery in its varied manifestations (science tool, cultural symbol, etc.)… Conversely, these authors indicate that there are innumerable forms of "paleoimagery" not qualifying as paleoart because "paleoartists are (modern) artists who create original skeletal reconstructions and/or restorations of prehistoric animals, or restore fossil flora or invertebrates using acceptable and recognized procedures" (Debus and Debus, 2011). Another recent definition for the term has been elaborated by the Society of Vertebrate Paleontology for its Lanzendorf PaleoArt Prize: "PaleoArt is broadly defined as the scientific or naturalistic rendering of paleontological subject matter pertaining to vertebrate fossils." (Web1). The paleoart definition suggested by the SVP cannot be accepted because it completely eliminates from paleoart great artwork related to invertebrates and their environments, such as those created by Édouard Riou and John Sibbick.

In order to establish such a definition, we made a consultation to members of the international paleontological community. The objective of this poll was to consider the opinion of the scientists in order to properly define and evaluate paleoart today.

2. Matherials and Methods

A questionnaire was sent to 115 paleontologists and naturalists related to paleontology of which 100 responded. They were settled in eleven different countries: Argentina (1 paleontologist), Brasil (1), Colombia (1), Turkey (1),

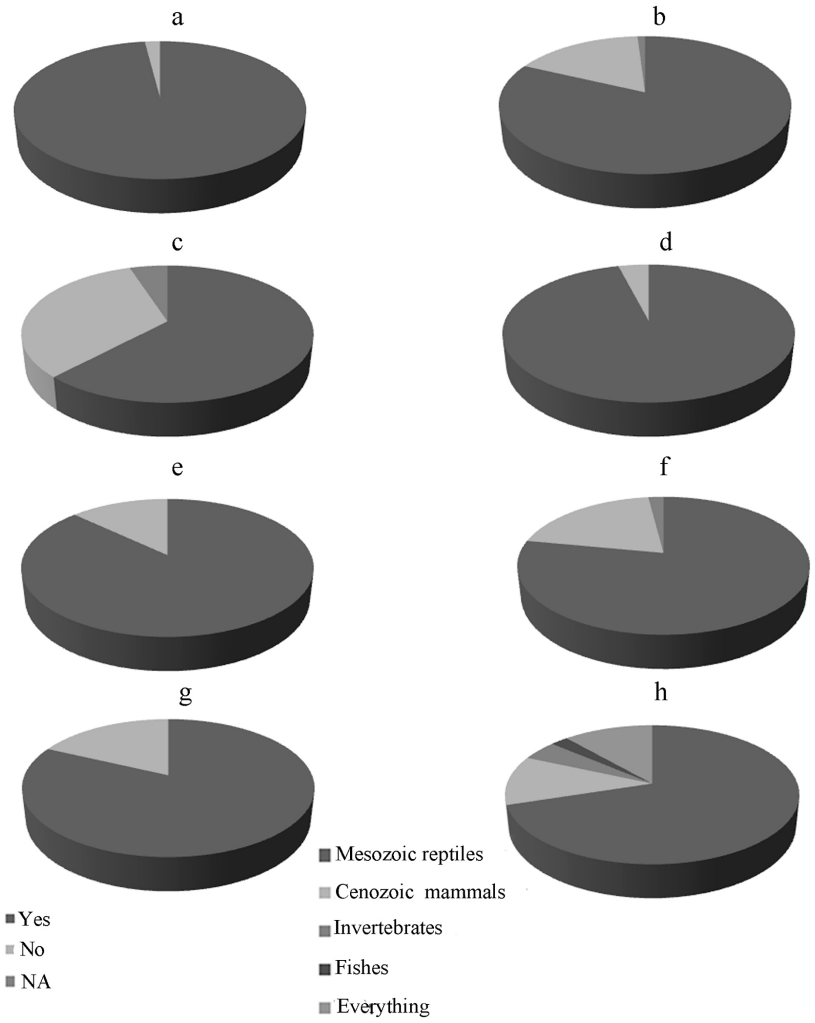

Figure 1. Results of the survey: a) Do you think that paleoart is necessary to communicate paleontology to the public?; b) Do you think paleoart is necessary to share knowledge between scientists?; c) Do you think paleontology has been inseparable of art in the last two centuries?; d) Do you know any paleoartist and his artwork?; e) Do you think accuracy in paleoart is growing in time?; f) Do you consider essential that paleoillustration or paleosculpure must be scientifically accurate to be considered paleoart?; g) Did you doodle, draw or model any extinct creature at any point of your childhood?; h) Prehistoric life groups pictured in childhood. NA means Not Answered.

Portugal (2), Mexico (5), France (6), Italy (6), U.S.A. (7) and Spain (70). The poll consisted in eight questions, the last one being optional response:

1. Do you think that paleoart is necessary to communicate paleontology to the public? This question tried to value paleontologists´ opinion about the current symbiosis between arts and paleontology as well as the necessity of art as a vehicle for the transmission of ideas and information to general public.
2. Do you think paleoart is necessary to share knowledge between scientists? Here we tried to value paleoart capability to transmit hypotheses and communicate ideas among paleontologists and other scientists.
3. Do you think paleontology has been inseparable of art in the last two centuries? It attempted to establish scientists' consideration on the symbiotic and positive relationship between art and paleontology during its last two centuries as a science.
4. Do you know any paleoartist and his artwork? Who? (3 maximum). This question expected to lay out the artists' recognition as individuals to the paleontologists. It is very difficult to be unaware of any paleoart artwork, either past or present, because at any moment of our life we may have come upon a piece of paleoart reproduced, for example, in museums or editorial publications. In fact, it is impossible to say that a paleontologist has ever seen a paleoart artwork because their mind is full of images depicting prehistoric life. The purpose of this question is to value how accepted and recognized are the creators of these artworks, which are so important for paleontology.
5. Do you think accuracy in paleoart is growing in time? This question examines the preeminence of scientific progress in the field of paleoart from its beginnings to the present.
6. Do you consider essential that paleoillustration or paleosculpture must be scientifically accurate to be considered paleoart? This is a key question to define paleoart. In our opinion, from the first representations of prehistoric organisms, in order to create an icon of them paleoartists have always attempted to reconstruct an accurate appearance of these beings. Therefore, this question was intended to contrast this notion within a ample sample of paleontologists.
7. Did you doodle, draw or model any extinct creature at any

point of your childhood? It comes from the book *Dinosaur Art*, where White (2012) stated his interest on "an straw poll amongst vertebrate paleontologists, particularly those who study dinosaurs, would reveal that many doodled (however badly) prehistoric animals as a child". This question helps to understand the necessity of visualization of the organism and the ontogeny of this necessity.

8. Finally, in relation to the previous question, we also asked about which taxa were represented by these young paleontologists to be.

3. Results and discussion

Paleontologists clearly consider paleoart as a key element in the visual transmission of paleontological knowledge (Figure 1a). Evidences of extinct organisms preserved only as fossils need to be interpreted and reconstructed in order to bring animals back to life for all publics. Additionally, with a 82% of positive result versus a negative 17%, the general opinion is to embrace paleoart as a good communication channel among scientists (Figure 1b), which is confirmed by the artistic support that many paleontology books and papers include.

The approval of the historic relationship between paleontology and art has been proved complicated for the survey respondents (Figure 1c). While 62 % of them accept the bond between paleontology and art along its history as a science, 33% do not recognize it and 5% refuse to answer. Beyond the clear separation between art and science, both are deeply intertwined (White, 2012). From the very moment in which Cuvier's artwork started to include restorations of fossil organisms, it is impossible to separate the growing of paleontology from associated art (Debus and Debus, 2011). If it were not for the artistic interpretation of fossils from past worlds, people's ability to assimilate their significance would have been diminished. Therefore, the progress that paleontology has made since the XIX century would have been clearly difficult and would have developed in a different way if art would not have supported paleontology. In our opinion, this makes impossible for us to deny the relationship between paleontology and art. Besides, paleoart has been undeniably used as a research methodology, for example, to estimate weight approximations through scale models (Christiansen, 1997; Paul, 1997) or in relation to size proportions (Antón, 2007). Nevertheless, despite of the commented evidences, our results prove that a fair part of the participants in the survey do not recognize the work that paleoart has realized in favor of their science.

Paleontologists who know different paleoartists as creators of different artwork rose up to 96% (Figure 1d). In this question it was allowed to name different artists (a maximum of 3 professionals) and some referential artwork. It is remarkable the fact that Mauricio Antón has been referenced by 60% of the total of polled people, even if they were not from Spain or their field of study was not vertebrate paleontology. With this question we have verified how different paleontologists assess the artists with whom they collaborate or who are from their own country. Maybe this explains a local recognition of the artists who are not so popular internationally (Table 1). It is also significant the fact that several classical masters within paleoart have not received as much recognition as probably they should; these are the cases of Zdeněk Burian, Charles R Knight and Rudolph Zallinger, mentioned only by 11-6 % of the respondents. Among modern paleoartists with international prestige but low recognition in our survey are John Sibbick (4 %) and Jay Matternes (2 %). These results appear to indicate a general low level of knowledge of the history of paleoart and its main representatives.

The acknowledgment of the work of paleoartists is variable within paleontology. Some species have been dedicated to renowned paleoartists: *Sellacoxa pauli* Carpenter and Ishida, *2010 and Cryptovolans pauli* Czerkas et al. 2002 to Greg Paul;

Table 1. List of the paleoartists mentioned by the survey respondents. Number of mentions in brackets.

1 Mauricio Antón	(60)	18 Karen Carr	(3)	35 Jacek Major	(1)
2 Raúl Martín	(22)	19 Mark Hallett	(2)	36 Matthew Martyniuk	(1)
3 Oscar Sanisidro	(21)	20 Scott Hartman	(2)	37 Matilde Muzquiz	(1)
4 Zdeněk Burian	(11)	21 A. & A. Kennis	(2)	38 Enrique Navarro	(1)
5 Charles R Knight	(10)	22 Jeff Martz	(2)	39 Guillermo Navalon	(1)
6 Rudolph Zallinger	(6)	23 Jay Matternes	(2)	40 Bob Nicholls	(1)
7 Davide Bonadona	(5)	24 Andrey Atuchin	(1)	41 Antonio Peñas	(1)
8 John Conway	(5)	25 Rob Bakker	(1)	42 Graham Rosewarne	(1)
9 Douglas Henderson	(5)	26 Aldo Castañeda	(1)	43 Nima Sassani	(1)
10 Greg Paul	(5)	27 Sergio de la Rosa	(1)	44 Humberto Serrano	(1)
11 Marco Ansón	(4)	28 Pewter De Scott	(1)	45 William Stout	(1)
12 Alain Beneteau	(4)	29 Danielle Dufault	(1)	46 Emiliano Trocco	(1)
13 Julius Csotonyi	(4)	30 Felipe Elías	(1)	47 Terryl Whitlatch	(1)
14 John Sibbick	(4)	31 Francesc Gascó	(1)	48 Emily Willoughby	(1)
15 Luis Rey	(4)	32 James Gurney	(1)	49 Mark Witton	(1)
16 B. Waterhouse Hawkins	(3)	33 René Hernández	(1)	50 Xen Yu	(1)
17 John Gurche	(3)	34 Julio Lacerda	(1)		

Ludodactylus sibbicki Frey et al. 2003 to John Sibbick; and *Torvosaurus gurneyi* Hendricks and Mateus, 2014 to James Gurney. On the other hand, plagiarism of paleoart pieces has become very usual in our society (Witton et al. 2014), which is only possible because of the combination of an increasing mercantilism of paleoart and a widespread ignorance of the paleoartists (past and present) as individuals and their works. Therefore, it seems crucial to increase the knowledge of the public, particularly among paleontologists, about the paleoart community and its members.

87% of the people who took the poll recognized the rise of accuracy in paleoart productions (Figure 1e). It is impossible not to acknowledge a rise of the accuracy and quality of paleoart artworks along its own history. In fact, since the beginning of the artistic restorations of prehistoric fauna, fossil discoveries came one after another and knowledge associated to them has been growing in time. This does not mean the first paleoartists were not accurate in their reconstructions, but they had to use their genius from the information they had, much less compared to the information nowadays. At the same time, they were limited by the thinking and ideas of that moment. Therefore, Paleoart can be considered an artistic manifestation of strict contemporaneity.

78% of answers stated the importance of scientific accuracy in paleoart, versus 20% denying it (Figure 1f). It seems contradictory that some scientists, who are those who must work to keep the scientific accuracy, have answered negatively to this question. For paleontologists should be mandatory that the artists, with their own sources and vision, were able to be precise and accurate when reconstructing an extinct organism. When the history of paleoart is taken into account, the target of artists and paleontologists has always been reconstructing the appearance of extinct organisms and the environments they lived in. When paleoartists create a piece of artwork, they are suggesting in a visual way the last hypotheses and scientific trends, synthetizing all the knowledge up-to-date. Paleoart must be accurate to represent extinct vertebrates and this can only be attained through the support of scientific knowledge. Since paleoartists have a commitment with the public when producing their artwork, their portraits of extinct taxa must include accurate reconstructions, beyond the artists' personal style. This is why, in order to generate paleoart, the artists must make an effort to include in their artwork all the available scientific evidence. When researchers and institutions commission works to professional paleoartists and work with them side by side, paleoartists can fulfill such aspiration. Nevertheless, there are still institutions and authors that use their status as scientists to justify art with low accuracy and quality produced by non-paleoartist illustrators. When art loses the level of accuracy that should be transmitted to the public, the scientific content that it supports will lose quality.

82% of the surveyed paleontologists drew different fossil organisms in their childhood (Figure 1g). Although some paleontologists with an important career did not draw extinct organisms during their childhood, it appears that from the very first moments of one individual's artistic manifestation and during the beginning of their fascination for prehistory there is already a necessity to sublimate our visions and ideas about the prehistoric world. Not surprisingly, the most pictured group was dinosaurs and associated Mesozoic fauna, having been drawn by 71% of the participants (Figure 1h).

According to the results of our survey, we must generate a definition that faces different problems of paleoart at the moment. Nowadays there is an increasing difficulty to recognize the pieces of paleoart within the larger field of paleoimagery. Being concise, paleoartists must be able to reproduce the anatomy of extant organisms accurately, which provides them with the knowledge required for the reconstruction and representation of extinct species. Nevertheless, we find ourselves facing today a saturation of images created by different artists that in many cases do not represent accurately the organism they claim to portrait. For this sort of images, Andrea Cau (Web 2) formulated the term 'paleoartism', referring to those representations of extinct organisms that are not supported by fossil evidences and scientific data. This problem is increased when museums and academic institutions commission paleoart production to artists who are not able to realize reconstructions and produce paleoart.

Similarly, many popular icons we may have of extinct species were generated from seminal representations by great paleoartists, whose work has become reiteratively reinterpreted. For example, the first scientific reconstruction of *Phorusrhacos* by Charles Knight included a feather crest (Lucas, 1901). Burian's later illustrations of this animal were based on Knight's original and gave it a white and black color pattern (Spinar, 1972). From Knight's original and Burian's derivative work, tens of representations of *Phorusrhacos* and related genera have been created, most of them based on the esthetic of these representations, which became a canonical form of the animal.

Two types of paleoartists can be differentiated according to their approach to the representation of extinct organisms: the researching reconstructors and the creative ones. Researchig reconstructors are those paleoartists who reconstruct the animal through different phases, which start directly from a deep research of the fossils, Creative paleoartists are those who use as a reference previous accurate reconstructions already made by another artists or by themselves. Thanks to their anatomical knowledge, they are able to create new correct representations of prehistoric organisms without the need to realize a reconstruction from scratch, which saves a substantial amount of time, as commented by Raúl Martín (White, 2012). Obviously, researcher paleoartists are also creative paleoartists. Taking this into account, the value of researcher paleoartists is very high within the world of paleoart.

In any case, one thing is to take as a reference an animal that has been already reconstructed by a paleoartist, and a very different one to openly copy another artist's image. As commented previously, plagiarism within the world of paleoartistic creations has become a serious problem for the present and future of this discipline (Witton et al. 2014). Copies generated for both commercial demand and the academic world, are sometimes produced by low-skilled artists or those limited by tight deadlines, which obtain their benefit from the previous research and artistic work of paleoartists. Bad-quality plagiarisms copied from paleoartists' artwork may be found even in museums. This results in paleoart despise, as well as indicates a disdain of the content and scientific accuracy of any exhibition or publication that includes such bad practices.

At the moment, the amount of resources to produce artwork, either an illustration or a sculpture, has increased noticeably, with a remarkable rise of the digital media. We can say that 3D digital modeling will be key in the future of paleoart, since it does not only allow us to realize a momentary rendering, a capture in the life of the depicted organisms, but it also allows us to realize animations. Subsequently, this technique makes us able to reconstruct the locomotion and behavior of animals (Antón, 2007). Two of the resources at their peaks are photo-manipulation and photo-collage, used in different ways by renowned paleoartists, like Mauricio Antón and Julius T. Csotonyi. Although paleoartist Raúl Martín separates these from digital painting, since he does not consider them as such (White, 2012), they can be fairly used in the artistic interpretation of the external appearance of extinct animals. However, a problematic situation happens when photo-collage is used directly to reconstruct animals, deconstructing and deforming extant animals to reach the body proportions of extinct taxa. The problem of this technique is that, if there is not a previous work of osteological and miological reconstruction, it is extremely difficult to get a reconstruction that is anatomically and morphologically correct. When we transplant directly the many subtle and distinctive aspects in the life appearance of an animal, what we are creating is the very same animal, recognizable although deformed. In our opinion, extant species must be a reference, not a direct translation of the image of the extinct animal itself. The paleoartist must reconstruct extinct organisms without succumbing to the temptation of directly transplanting information from any extant species.

The lack of recognition of paleoart by some scientists and the malpractices described previously are worrying issues. These are obstacles paleoart need to get over in the future.

Taking into consideration the results of our survey and the history of this discipline, we define paleoart as any original artistic manifestation that attempt to reconstruct o depict prehistoric life according to the current knowledge and scientific evidence at the moment of creating the artwork. As such, this artwork must show a high level of artistic skill and knowledge in anatomy, ecology and ethology.

In spite of the fact that old artwork is based on out-dated hyphotheses, this definition would include the artwork of old great masters of paleoart, whose mistakes were conditioned by the thought and knowledge of the moment. In this way paleoart contemporary esthetics keeps adapting in accordance to the contemporaneity of the scientific knowledge and thought.

Our definition excludes different kinds of paleoimagery that are not qualifying as paleoart. This could be because they are not scientifically accurate, are out of date at the moment of generating the artwork or have no artistic as well as scientific value.

4. Conclusions

Beyond its artistic value, paleoart has also scientific importance, due to its function in visualization of the subjects of study as living forms, the help that provides in taking some paleobiological data, and its role in the proposal of new hypotheses.

Taking this into account, paleoart must show to the public the most accurate reconstruction of the appearance of organisms and environments of the past that is possible. Since they will turn into the public mental representation about that organism, these iconic representations should encapsulate all anatomic, ecologic and ethologic concepts derived from the scientific study of data related to such organisms or environments. We have made a definition of paleoart that summarizes all these issues. At the same time, our definition protects paleoartists' creations by not considering plagiarism as paleoart.

We hope that this definition of paleoart will help to improve the public recognition within fine arts and science of this discipline and the true paleoartists who practice it, and to separate them clearly from the non-academic paleoimagery.

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