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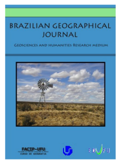

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The briefing in paleodesign: selection and arrangement of data for the reconstitution of paleovertebrates

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ABSTRACT

Representing visually the external appearance of an extinct animal requires, for a reasonably reliable and expressive reconstitution, a good compilation and arrangement of the scientific conclusions on the fossil findings. It is proposed in this work an initial model of a briefing to be applied in a paleodesign process of a paleovertebrate. Briefing can be understood as a gathering of all necessary data to perform a project. We point out what must be known about the relevant structures in order to access all the data and the importance of such information. It is expected that the present briefing suggested might be faced with flexibility, serving as a facilitating interface of the relation between paleoartists and paleontologists.

PALAVRAS CHAVE:
Briefing
Paleodesign
Paleovertebrado
Paleoreconstrução

RESUMO – BRIEFING EM PALEODESIGN: SELEÇÃO E ORDENAÇÃO DE DADOS PARA RECONSTRUÇÃO DE PALEOVERTEBRADOS. Representar visualmente a aparência externa de um animal extinto exige uma boa compilação e ordenação das conclusões científicas sobre os achados fósseis, para que esta reconstituição seja razoavelmente informativa e realística, (não esta claro o que o autor quis dizer). Propõe-se aqui um modelo inicial de *briefing* para ser aplicado num processo de paleodesign de um paleovertebrado. *Briefing* pode ser entendido como sendo a reunião de todos os dados necessários a execução de um projeto. Explicita-se aqui o que se deve saber sobre as estrutura relevantes, o caminho para se encontrar cada dado e a importância de tal informação. Espera-se que a proposta de briefing seja encarada com flexibilidade e sirva como interface facilitadora da relação entre paleoartistas e paleontólogos.

1. Introduction

The visual concept of a fossil species living integrated to its past habitat is the main objectives of the paleontology field called paleodesign. The term paleodesign is better that "paleoart" because this last could show stuffs like mugs, ceramics and clothes with dinosaurs to paleontologists, for example. So paleodesign is a branch of the art applied to the paleontology and Ghilardi; Ribeiro; Elias (2007) made a description of this process and recommended that, at a first methodological stage on the study of paleoreconstruction, the highest number of the available scientific data related to the specimen and its respective paleoenvironment should be compiled. This step includes the bibliographical review, the direct morpho-anatomical analysis of the fossils, analogy studies with currently living species, as well as investigations of sedimentological, stratigraphic and taphonomic nature. Phylogenetic studies also can provide an analysis of fossil. Witmer (1985), for example, propose the use of Extant Phylogenetic Bracket (EPB) that utilize at least the first two extant outgroups of the fossil taxon of interest. Nevertheless, in some cases systematic is poor resolved and the mistake of hypotheses *ad hoc* could to bring a misunderstood to the scientist. By doing so it is possible to have a general notion of the appearance, behavior and contextual environment of the studied species, allowing a detailed planning and, consequently, an effective reconstruction.

Ghilardi; Ribeiro; Elias (2007) proposed the term briefing to identify such step of the execution of a paleodesign. Briefing can be understood, thus, as the gathering of all the necessary data to the successful execution of a project (STRUNCK, 2001).

Authors like Paul (1987, 1988, 1997 and 2003) and Czerkas (1997) propose and discuss the ways to reconstitute extinct animals, however, proposals for the selection and arrangement of the information relevant to the visual reconstruction of paleovertebrates, showing the main anatomical and morpho-functional characteristics about the animal to be reconstructed, as well as its environment and ecology, are not found in the literature (exception to Lagerstätten preservation like Liaoning fauna from China). Moreover, methods to achieve satisfactory results for each item have not been proposed either, despite being relevant to the accomplished studies of restoration (SWINTON, 1969), since the selection of information may facilitate the acquisition of the necessary data to the restoration of an extinct being and encourage paleoartists to a more coherent and detailed execution. Such fact allows a better planning of the execution of the illustration or sculpture, thus providing a better transmission of the information.

Therefore, generating and proposing a model of compilation of the scientific information in order to facilitate the making of briefings to the paleodesign is of extreme importance to the paleoartists with their restoration work and to paleontologists in divulgation and visualization of their researches.

2. Briefing in paleodesign

Firstly, it seems more appropriate to make use of the previously existing literature to obtain a briefing with coherent information. At a later stage, the data which have not been found in previous studies should be based on a thorough osteologic investigation of the fossil. It is clear that some topics displayed in the tables will not be accurately defined, since several elements are not preserved (HOLZ; SIMÕES, 2002). Such topics must be established based on comparisons with extant animals within a same systematic group of similar environment and body structures.

We have selected and ordered dozens of topics relevant to the anatomy, ecology and physiology of the animal. Such data have been arranged into three tables (TAB. 1A, 1B, 1C, 2 and 3). The first one suggests the gathering and selection of the morpho-anatomical data which compose and influence the external appearance of the animal. The second table refers to their paleobiological context, collecting information on both physiology and behavior. The last table gathers data of the animal under the paleoenvironmental and paleoecological contexts. Such table contents elucidate what must be known about every structure, the path to find every piece of data and the relevance of such information. Below, it is presented the discussion on the parameters and structures that turned out to be most important in the paleodesign of vertebrates.

2.1 Morphoanatomical context

2.1.1 endoskeleton

For the reconstruction of the external appearance of a paleovertebrate, it is necessary to know the biometry, the morphology and the exact functional arrangement of the skeletal elements. Although the description of the fossil finding is not required for its reconstruction and restoration, the understanding of the relationship between the bony parts, i.e., the way which they articulated to each other in life and their exact dimensions, is fundamental (GHILARDI; RIBEIRO; ELIAS 2007).

Thus, in order to clarify the necessary data for the structure in question, it is recommendable to carry out a morphologic and taxon-associated analysis of the fossil species and the extrapolation of data of closely-related or analogous taxa, comprising both fossil and living beings. An individual metrical analysis of the bony elements is necessary.

The axial skeleton is a determinant feature in the length of the animal, the distance between the limbs and the silhouette of the animal as well. The length in life must be estimated adding the length of the skull to the length of every available vertebra, plus the probable thickness of the intervertebral discs and the estimation, based on closely related taxa, of the non-preserved vertebrae.

The knowledge of the dimensions and behavior of the appendicular skeleton is indispensable to determine the height and the locomotion mode of the animal.

The skeletal paleorestoration is essential for later paleoreconstruction of the skeleton, which will allow the inference of the insertion and origin sites of the musculature and, therefore, estimate the volume and external appearance of the animal (GHILARDI; RIBEIRO; ELIAS) (FIG. 01).

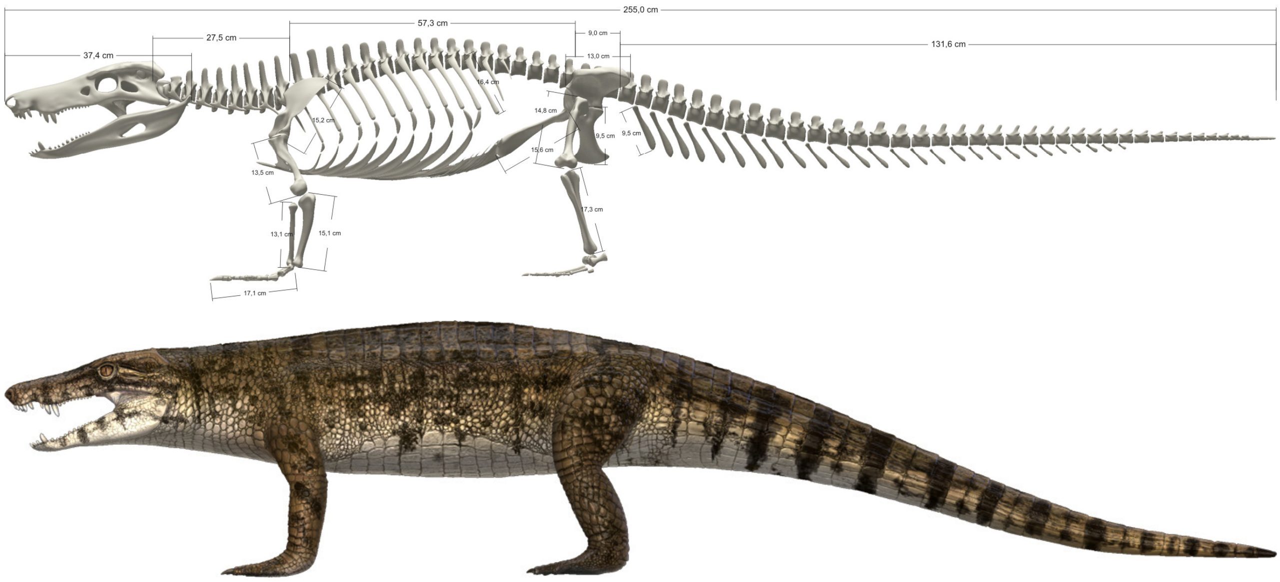

Fig. 1. Skeleptical and tegumentary paleoreconstruction of *Uberabasuchus terrificus*.

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2.1.2 Musculature

The skeletal muscular system is the most important feature to determine the volume of an extinct animal and, therefore, its external appearance. To do so, it is necessary to discover or deduce the origin of the insertion, the dimension and volume of every muscle so that all the superposition of flesh leads to a final volume as close as possible to the reality.

The point in getting knowledge about the musculature and other information, as force and resistance, is to determine the dimensions and the arrangement of the muscular bundles, inferring thereby the body mass, the biomechanics of the sustainability of the body mass by the members, the patterns and extension of articulations and mobility, as well as their respective physical capabilities and limitations.

To obtain such data, the analysis of the surfaces of the muscular insertion and grooves present on the surface of bony structures of the fossil species associated to their taxa is needed. Furthermore, the analysis of the points of osteologic articulation, integrated biomechanical analysis between skeletal and muscular complex within the taxon, investigation of ichnofossils associated to the taxon or to individuals from close taxonomical groups and the biomechanical comparison with modern analogous species is indispensable.

Besides determining the volume and substantially contributing to the animal mass, the musculature determines, along with the skeleton, the mode of locomotion and the strength of the animal, elements which compose the representation of an extinct animal. (PAUL, 2003).

2.1.3 Locomotion

The way an animal moves defines its posture, which is extremely important to the representation of an animal, even in a motionless figure. Osteologically, an examination of the morphology of the ilium, the bones of the legs (mainly the back ones) and the bones of the paws, besides the vertebrae and distribution of the osteoderms, is essential to infer, reliably, the movements of a paleovertebrate (HUTCHINSON, 2006).

2.1.4 Tegument

In a reconstruction of the living animal, the skin is virtually the only visible interface between the paleontological data of the animal and the spectator. All the rest, that is, the internal parts, serve to reconstruct the shape for what is really drawn or sculpted the tegument.

To represent the skin, whether in a sculpture or an illustration (digital or manual), it is necessary to know how it was, in life, the texture of the skin, its thickness, the kind of connection with the muscular and osteological structure, besides the coloration If the skin had scales, it is indispensable to know their shape, dimensions, the patterns of insertion and articulation, the reflective properties and the coloration. It is necessary, therefore, to undergo an investigation of the tegument segments associated to the taxon or individuals from close taxonomical groups, when preserved in the fossil register.

Yet, the skin could be covered by fur or plumage; in this case, it is important to know the length of the structures, the morphology, distribution, density, functionality and color. To discover such information, it is recommended the investigation of impressions of fur segments, plumaceous and/or feather-like structures, when preserved in the geological record, associated to the taxon or to individuals of close taxonomical groups and also a comparison with the analogous tegumentary covering present in modern species should be made.

Concerning the tegumentary structure of the paleovertebrates, other appendices might be added, such as horns, crests, dermal plates, osteoderms, ramphoteca, etc. It is necessary to know their embryonic nature, dimensions, morphology, distribution, pattern of insertion, presence or absence of the covering tissues and their functionality.

To compose the tegument, it is always recommendable to perform an osteological analysis of occasional impressions preserved in the fossil of the species or individuals of close taxonomical groups in the process of paleodesign, besides the application of the principle of actualism on the comparison with current beings. The latter suggestion is the most probable and viable strategy to define the coloration of an extinct animal. It is suggested the observation of the texture and coloration of animals which belong to similar niches, which have similar sizes and comparable life habits.

2.1.5 Sensorial system

Eyes

The eye is of extreme importance because it is one of the most observed – or the first to be observed – in an illustration. To reconstruct the eye of a paleovertebrate, it is necessary to know the size of the orbits, the existing proportion between the size of the orbit and the size of the eyeball, as well as the exposed area of the eye, in other words, the opening of the eyelids. It is important as well to know the thickness of the cornea, the shape of the pupil, the color and degree of the iris aperture, besides the way the eyelids operate and the presence of any protective membranes.

To discover the aspects described above, it is necessary analyze morphologically and metrically the optical cavity in the braincase of the fossil species associated to the taxon and compare with modern species with analog structures.

Ears

To judge how large the ears would be, their placement in the braincase and the presence or absence of pinna, it is necessary to know, at least, the external morphology of the ear of the taxon being studied. Thus, it is possible to acquire information as the placement and metrics of the auditory canal. When possible, it is recommended to analyze the dimensions of the ear lobes based on a model of the brain structure projected from the internal portion of the brain cavity by comparison with analogous structures present in modern species. Inferences on the external aspect of the auditory complex, presence and mobility of the pinna are important to represent the animal, mainly under an ecological context.

Nostrils

It is necessary to know the possible superficial musculature, dimensions and placement of the nostrils in the brain case and, yet, the olfactory capacity of the animal. To accomplish that, the nasal cavity in the braincase of the fossil vertebrate should be metrically and morphologically analyzed, coupled with comparisons with analogous structures present in modern species. It is also possible, when preserved, to analyze the cerebral structure of the olfactory lobes of the fossil finding.

Oral cavity

If the buccal cavity of the animal has to be represented in a drawing or sculpture, it is indispensable to know the placement of the bones of the palate, the morphology of the throat and the embodied structures, as well as the morphology, dimensions, texture and coloration of the tongue.

As for the dentition, it is essential to know the morphology of the teeth, the structure of the enamel, the number of teeth in each maxillary branch, the degree of implantation in the maxillary branch, the rates and patterns of dental distribution and occlusion. Another important aspect from the artistic standpoint of the reconstruction is the coloration of the teeth which must be based mainly on the analogy with living animals.

A morphological and metrical analysis of the isolated teeth and the oral cavity is suggested, including analyses of the dental micromorphology, a detailed study about the internal structure, thickness and presence (or absence) of ornamentation on the dental enamel, morphological analysis of the roots and the dental alveoli, observation of the morphological and dimensional variability of the dental elements along the maxillary branches, as well as the biomechanical analysis of the resistance of the dental elements in comparison with analogous structures present in modern species. All these studies may allow the inference on the animals diet and food preferences, which seems to be of highest importance, depending on the representation to be done.

Tab. 1. A. Resume of the Briefing in the Morphoanatomical Context.

Morphoanatomical Context				
Structural Complex	**Individual structures involved**	**Parameters to be considered**	**Investigation approach**	**Goals**
Endoskeleton	- Axial Skeleton - Appendicular Skeleton	- Morphology - Dimensions - Volume	- Morphological and taxon-associated analysis of the fossil species - Metrical analysis of individual elements - Morphological comparison with analogous structures in modern species	- Determination of the placement of individual bony elements - Structural osteological reconstruction of the taxon
Musculature	- Muscular bundles - Tendons - Ligaments	- Morphology - Dimensions - Volume	- Muscles scars and insertion surfaces in the bone structures - osteologic analysis of articulation sites	- Determination of the shape, dimensions and placement of the muscular bundles - Inference on body mass - Muscular structural reconstruction of the taxon
		- Behavior of the articulations - Flexibility - Strength - Resistance	- Integrated biomechanical analysis between the skeletal and muscular complex associated to the taxon - Investigation of ichnofossils (isolated tracks and traces) associated to the taxon or closely related taxonomical groups - Biomechanical comparison with modern analogous species	- Determination of strength and muscular resistance - Determination of the biomechanical capacity of sustaining the body mass by the body - Determination of articulation extension patterns - Determination of the shape and pattern of mobility, as well as its respective physical capacities and limitations - Study of locomotive ability (pattern of motion, agility and velocity)
Tegument	- Skin	- Texture - Thickness - Type of connection and osteologic structure - Coloration	- Investigation of impressions of tegument segments associated to the taxon or individuals from close taxonomical groups when preserved in the fossil record - Comparison with the analogous tegumentary cover present in extant species	- Reconstruction of the tegumentary cover of the taxon - Inferences concerning acceptable patterns of coloration

	- Scales	- Shape - Dimensions - Pattern of insertion - Pattern of articulation - Coloration	- Investigation of impressions of squamous tegument segments associated to the taxon or individuals from close taxonomical groups, when preserved in the fossil record - Comparison with the analogous tegumentary cover present in modern species	- Reconstruction of texture patterns, variability of dimension and shape of scales in different portions of the body - inferences concerning reflectivity pattern and/or opacity of the surface of the scales - Inferences concerning acceptable coloration patterns to the taxon
	- Fur	- Dimensions - Morphology - Distribution - Density - Functionality - Coloration	- Investigation of impressions of segments of the fur associated to the taxon or to individuals of close taxonomical groups, when preserved in the geological record - Comparison with analogous tegumentary coating present in modern species	- Reconstruction of the tegumentary cover of the taxon - Inferences concerning acceptable coloration patterns

Tab. 1. B. Resume of the Briefing in the Morphoanatomical Context.

Structural Complex	Individual structures involved	Parameters to be considered	Investigation approach	Goals
Tegument	- Plumage	- Dimensions - Morphology - Distribution - Density - Functionality - Coloration	- Investigation of impressions of plumaceous and/or feather-like structures associated to the taxon or to individuals of close taxonomical groups, when preserved in the geological record - Morphofunctional analysis - Comparison with the analogous tegumentary cover present in modern species	- Restoration of the tegumentary cover of the taxon - Determination of the type and shape of this structure in the taxon - Inferences concerning acceptable coloration patterns
	- Other adornments (horns, crests, dermal plates, osteoderms, rhamphoteca etc.)	- Embryonic Nature - Dimensions - Morphology - Distribution - Pattern of insertion - Presence or absence of covering tissues - Functionality	- Osteological investigation and/or investigation of the impressions of the structure associated to the taxon or to individuals of close taxonomical groups, when preserved in the geological record - Morphological analysis - Histological analysis - Comparison with analogous accessory structures present in modern species	- Restoration of the tegumentary cover of the taxon - Inferences concerning the external aspect of the structure - Inferences concerning acceptable coloration patterns

Sensorial system	- Eyes	- Morphology - Dimensions - Volume - Disposition on the skull - Iris coloration and texture - Pupil format and degree of deformation - Eyelids morphology and action - Presence or absence of protective membranes	- Morphological and dispositional analysis and measuring of the optical cavity in the braincase of fossil species associated to the taxon - Analysis of the dimensions of the ocular lobes in a model of the cerebral structure projected from the internal portion of the cavity - Comparison with analogous structure present in modern species	- Ocular external restoration - Inference on the structure of the eyeball and implication in the visual acuity - Determination of the placement of the eyeball inside the braincase and its implication in the view field
	- Ears	- External morphology - Dimensions - Placement in the braincase - Presence or absence of pinna	- Morphological, positional and metrical analysis of the auditory cavity in the braincase of fossil species associated to the taxon - Analysis of the dimension of the earlobes in a model of the cerebral structure projected from the internal portion of the brain cavity - Comparison with analogous structure present in modern species	- Inference on the external aspect of the auditory complex - Inference on the presence, morphology and probable motility of the pinna - Determination of the auditory acuity of the taxon
	- Nostrils	- Internal morphology - Dimensions - Placement in the braincase - Surrounding musculature	- Morphological, dispositional and metrical analysis of the nasal cavity in the braincase of fossil species associated to the taxon - Analysis of the dimension of the auditory lobes in a model of the cerebral structure projected from the internal portion of the brain cavity - Comparison with analogous structure present in modern species	- Inference on the external aspect of the nostrils - Determination of the olfatory acuity of the taxon

Tab. 1. C. Resume of the Briefing in the Morphoanatomical Context.

Structural Complex	Individual structures involved	Parameters to be considered	Investigation approach	Goals
Buccal complex	- Palate - Tongue	- Morphology - Dimensions - Tissue revetment - Color - Mobility	- Morphological and metrical analysis of the internal cavity of fossil species associated to the taxon - Comparison with analogous structure present in modern species	- Inferences on the internal morphology of the oral cavity and the involved structures - Inferences on the dimensions, morphology and motility of the tongue

	- Dentition	- Morphology - Structure of the enamel - Number of teeth on each maxillary branch - Degree of implantation - Rates and patterns of substitution - Dental occlusion	- Morphological and metrical analysis of the isolated teeth of fossil species associated to the taxon - Analysis of the dental micromorphology, including a detailed study of the internal structure, thickness and presence (or absence) of ornamentation on the dental enamel - Analysis of the morphology of the roots an their nature - Analysis of the morphology of the dental alveoli - Analysis of the morphological and dimensional variability of the dental elements along the maxillary branches - Dental analysis of wearing patterns and/or fracture on the surface of the crown - Biomechanical analysis of resistance of the dental elements - Comparison with analogous structure present in modern species	- Inferences on diet and food preference - Inferences on the appearance of teeth

2.2 paleobiological context

Understanding how an extinct animal used to behave in order to obtain food, to move, reproduce and survive is absolutely necessary to represent the animal contextualized in its environment.

Termoregulation

Inferring on the metabolic patterns and body temperature regulation strategies depends on deducing certain behavior which may be illustrated in the paleodesign. Such conclusion can be achieved through the analysis of tissue slides, besides the bony elements of the fossil.

Feeding behavior

The feeding behavior determines what can be represented visually as food to the animal and how it obtains it. Such behavior can be inferred by analyzing the osteologic characteristics of the fossil specimen, mainly concerning to the dentition, shape of the skull, muscular insertions of the mandible, besides claws and post-skull sensorial and cerebral structures in general. The investigation of ichnofossils (occasional bite marks, coprolites, gastrolites) associated to the taxon or individuals of close taxonomical groups would represent the interaction among the individuals.

Thus, it is possible to deduce the preferential diet, occasional locomotive abilities and correlation with the ability of obtaining food, techniques and mechanisms of acquisition and food processing.

Social and sexual behavior

A representation of an animal within its environment will probably involve some situation of its daily life. Determining such situation to a fossil animal is extremely difficult. Inferences on the locomotive, social, feeding and reproductive habits of living animals are mandatory aspects of portraying an extinct animal in its habitat. For such both osteologic and taphonomic studies of what has been preserved in relation to the animal and the sedimentary environment are required, besides observations of the behavior of closely related living species. Inferring over important motive and sensorial abilities for the interaction among individuals of a same species over behavioral mechanisms and degree of cerebral complexity in a way to determine occasional abilities of recognition among individuals of the same species, occasional gregarious behavior, degree of antagonism among individuals of the same species, degree of sexual dimorphism and possible social structure is important for the contextualization of the animal. These data are only viable through the analysis of sensorial and cerebral structures, the occasional presence of structures or adornments, investigation of ichnofossils (tracks and footprints, markings of antagonistic interaction, eggs and shells, nests) and the degree of fragmentation of eggshells (ovoviviparous) present in the nests, based on the occasional presence of preserved leftovers in nests or dens, besides analysis of occasional embryos preserved underneath the abdominal case of fossil species associated to the studied taxon and comparison with modern analogous species. Thus, it would be possible to infer the behavioral aspects of mate selection and mating rituals, reproductive behavior (den or nest-builders, egg-layers or viviparous), parental care, and yet the degree of development of the newborn and their survival abilities after birth.

Ontogenetic development

The ontogenetic development of a fossil animal is difficult to understand (VASCONCELLOS; CARVALHO, 2005). It is important to know how the animal was in its different stages of development to visually represent them, if the project so requires. If the animal has gregarious habits, it would be likely to find individuals at different stages of development within a herd. If one of their most remarkable characteristics is, for instance, the offspring care, the illustration should highlight such feature, thus relying on the knowledge of the external appearance of the animal as a newborn. The osteologic structure and the degree of ossification of the newborn fossil species must be analyzed, as well as the morphological variation among fossil species at different ontogenetic stages associated to the taxon. When preserved individuals at different developmental stages are unavailable, it is fundamental to analyze fossils from close taxa or analogous living animals.

Vocalization

The sounds emitted by an extinct animal are of extreme relevance in a reconstruction if it involves a motion portrayal as in animations and videos, or yet in animatronics, as the mechanical structures that imitate animals are so called. It is possible to analyze the brain, the phonemic organ and occasional acoustic compartments, when preserved with the fossil, which allows the interference in the tone and sound intensity and degree of complexity (language). Again, it is recommendable, and, in some cases it is the only way, to deduce the sound produced by extinct animals by comparing and studying modern animals.

Tab. 2. Resume of the Briefing in the Paleobiological Context.

<table>
<tr><th colspan="4">Paleobiological Context</th></tr>
<tr><th>Biological conditioner</th><th>Considered parameters</th><th>Investigation approach</th><th>Goals</th></tr>
<tr><td>Physiology</td><td>- Endothermy x Ectotherm</td><td>- Analysis of tissues slides</td><td>- Inferences on the metabolic patterns and consequent behavior</td></tr>
<tr><td rowspan="4">Behavior</td><td>- Feeding behavior</td><td>- Analysis of the dental structure and the mandible complex of fossil species associated to the taxon

- Analysis of the osteological structure and biomechanical inference of fossil species associated to the taxon

- Analysis of sensorial and cerebral structures of fossil species associated to the taxon

- Investigation of ichnofossils (occasional bite markings, coprolites, gastrolites) associated to the taxon or to individuals from close taxonomical groups

- Analysis of any occasional sign of interaction among individuals in the fossil remains

- Comparison with analogous modern species</td><td>- inferences on the preferential diet

- Inferences on techniques and mechanisms of acquisition and processing of food

- Inferences on occasional gregarious techniques of obtaining food</td></tr>
<tr><td>- Social and reproductive behavior</td><td>- Analysis of the sensorial and cerebral structures of fossil species associated to the taxon

- Analysis of occasional structures or adornmentation present in fossil species associated to the taxon

- Investigation of ichnofossils (tracks and footprints, markings of antagonistic interaction) associated to the taxon or to individuals of close taxonomical groups

- Analysis of the degree of sexual dimorphism among fossil species associated to the taxon

- Analysis of the degree of fragmentation of eggshells (ovoviviparous) present in the nests

- Analysis of occasional preserved embryos underneath the abdominal cavity of fossil species associated to the taxon

- Comparison with analogous modern species</td><td>- Inferences on the motive and sensorial abilities, important to the interaction among individuals of the same species

- Inferences on the behavioral mechanisms and degree of cerebral complexity, in order to determine occasional recognition abilities among individuals of the same species

- Inferences on the occasional gregarious behavior

- Inferences on the antagonism degree among individuals of the same species

- Inferences on behavioral aspects of mate selection and mating strategies

- Inferences on the reproductive behavior (den or nest-builder, egg-layer or viviparous)

- Inferences on the participation of the parents in the care of the offspring

- Inferences on the possible social structure

- body changes during the mating season</td></tr>
<tr><td>- Ontogenetical development</td><td>- Analysis of the osteological structure and the degree of ossification in newborn fossil species associated to the taxon

- Analysis of the morphological variation among fossil species at different ontogenetic stages associated to the taxon

- Comparison with modern analogous species</td><td>- Inferences on the degree of development of the newborn and their abilities to survive after birth

- Inferences on the ontogenetical development, including differentiation between the sexes along the growth, morphological changes and growth rates</td></tr>
<tr><td>- Vocalization</td><td>- Analysis of cerebral structure of fossil species associated to the taxon

- Structural analysis of the phonation organ and occasional structure(s) of acoustic compartment(s) (structures of resonance) when existing and preserved in the fossil(s)</td><td>- Inferences on the pitch, intensity and timbre (sound nature) of the sounds emitted by the animal

-Inferences on the degree of complexity (language) of the emitted sounds.</td></tr>
</table>

2.3 paleoenvironmental and paleoecological context

When reconstructing a creature inserted in an environment it is unquestionable that the necessary data for the correct reconstruction of the concomitant fauna, the color and texture of the soil, the possible vegetation, humidity-related events (rain, clouds, fog), possible presence of water sources and local characteristics of the land must be collected. The osteology of a fossil reflects the environment and the study of the environment reciprocally corroborates the habits and external appearance of an animal (GHILARDI, 1999).

To reconstruct the environment in which the sedimentary deposit was generated, i.e., to determine the paleoenvironmental and paleolandscape appearance, it is necessary a general characterization of the rocks which compose the fossiliferous horizon (lithology) as coloration, granulometry of the sediment, degree of compactness, chemical composition, faciological and sedimentological characterization, trying to find characteristics which diagnose the depositional system involved. It is also recommendable the mapping of the placement of the lithostratigraphic horizon in which the fossil material is found and the analysis of the associated fossil content, besides the comparison with modern depositional systems. Features such as the paleolatitude, paleogeography and paleoclimate, which certainly have influenced the extinct landscape, must be also taken into consideration. Average temperature, relative humidity, pluviosity and associated events are fundamental to deduce the coloration and nebulosity of the sky, so the illustration can portray rain, lakes or deserts. It is necessary then, to access the sedimentological, palynological, micropaleontological and geophysical data, as well as to compare the fossiliferous content with other isochronous stratigraphic units in different geographical areas.

Associated paleobiota

The fauna associated to the moment of life of an animal which is object of reconstituition is indispensable to the reconstruction of the paleoenvironment. Very likely an animal is not alone if portrayed in an open angle showing a great part of the environment. It is interesting to portray animals in the background and vegetation around them, for besides being didactic, it is important to fossils contextualize the illustration. It is necessary, thus, to determine the fauna and flora fossils associated to the paleoenvironment and infer on the paleoecological relationships between them in order to achieve a complete paleobiotic reconstitution. For the reconstruction of the ecological relations of the analyzed taxon based on inferences of the niche it occupies within its respective paleoecosystem, it is necessary to analyze occasional evidences of interaction between species (paleoichnology), and statistic analyses of components of the fossil assembly associated to the analyzed taxon (relative population, predator/prey relationship, etc.).

Tab. 3. Resume of the Briefing in the Paleoenvironmental and Paleoecological Context.

Paleoenvironmental and Paleoecological contexts			
Paleoenvironmental conditions	Parameters to be considered	Investigation approach	Goals
Sedimentation paleoenvironment	- Paleorelief	- General characterization of rocks which compose the fossiliferous horizon (lithology) as to coloration, granulometry of the sediment, degree of compactness, chemical composition - Faciological and sedimentological characterization, in order to find characteristics which diagnose the depositional system involved - Comparison with modern depositional systems - Mapping of the placement of the lithostratigraphic horizon in which the fossil material is found - Analysis of the associated fossil content	- Resconstituition of the environment in which de sedimentary deposit was generated = paleoenvironmental and paleolandscape restoration
	- Paleolatitude	- Comparison of the sedimentary composition with other isochronous stratigraphic units in different geographic areas	- Inferences on the geographical context associated to the paleoenvironment
	- Paleogeography	- Comparative analysis of the fossiliferous content with other isochronous stratigraphic units in different geographic areas - Palynological analysis - Geophysical analysis	
Paleoclimate	- Average temperature - Relative Humidity - Pluviosity	- Sedimentological analysis - Palynological and micropaleontological analysis	- Inferences on the average seasonal and/or annual temperature, humidity and pluviosity of the analyzed paleoenvironment - Inferences obout the kind of clouds in the sky, presence of eventual fog, presence of water in the land, etc

	- Associated events	- Analysis of particular sedimentary features	- Inferences on the occurrence of punctual and/or cyclical events of relevance to the paleoenvironment
Associated paleobiota	- Fauna - Flora	- Qualitative and quantitative analysis of the animal and vegetal species associated in the same horizon where the fossil species associated to the taxon were collected - Analysis of the distribution patterns of the fauna associated within the context of the fossiliferous horizon - Comparison with the faunal and floral composition in modern ecosystems	- Determination of the fossil species associated to the paleoenvironment and inferences on the paleoecological relation among them = complete paleobiotic reconstruction

3. Discussion

Ghilardi; Ribeiro; Elias (2007) suggest a modality within the paleoart in which the first step comprises the gathering of all data concerning the extinct animal and environment to be portrayed. Such procedure allows a good performance of the project plan, besides making the reconstruction reasonably reliable to what existed back then, and thus, didactic. It is believed that if professional and amateur paleoartists rely on an organized arrangement of data, the reconstructions will eventually be better. Nonetheless, this recipe is not supposed to be inflexible and strictly followed; on the contrary, this work should be seen as an initial proposal focused on facilitating the work of the paleoartists in their search to bring a reconstruction closer to the fidelity the paleontologists pursue.

For being one of the ways to see the extinct past (GHILARDI; RIBEIRO; ELIAS, 2007), the paleoart has been receiving a remarkable attention. It is didactic and attractive for the scientific diffusion. The techniques and supports (MUNARI, 1989) of the art and design apllied to the paleontology do not serve only to represent the external appearance of the animal, actually there are several researches in biomechanics (*e. g.* STEVENS; PARRISH, 1996; HENDERSON, 1999; STEVENS, 2002; HUTCHINSON *et al.* 2005) and mass calculation (MOTANI, 2001) using the visual restoration and software of three dimensional manipulation.

4. Conclusion

The paleoartist is not necessarily a paleontologist. Thus, in many cases, he does not have all the necessary knowledge about the extinct animals and environments he must portray. The briefing suggested here may work, therefore, as a facilitating interface of the relationship between the artist and the paleontologist. In possession of a detailed guide adapted to his necessities, the paleoartist can be more direct and specific when investigating the characteristics of the species in the paleodesign to be portrayed.

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