

PaleoParks: Our paleontological heritage protected and conserved in the field worldwide

[Les Paléo-Parcs : Notre patrimoine paléontologique protégé et préservé sur site à travers le monde]

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Abstract: Fossil occurrences across the world are endangered by development, construction, collecting, and vandalism, even though many outstanding examples have been protected by World Heritage Sites, national parks, monuments and reserves, state and provincial parks, and local government and non-profit organizations, as well as some private individuals. The International Palaeontological Association (IPA) established a Paleoparks Initiative to protect endangered sites and to catalog and make public established parks of any nature that protect fossils in the ground, a primary source of scientific data, educational opportunities and recreational activities, as well as key places protecting "living fossils".

IPA has 15 aims and goals and a web site for documenting both established and proposed sites. IPA sponsored meetings and workshops at three international meetings over the past five years to discuss these problems, successful solutions, and its goals and aims.

Ten examples of Paleoparks are presented in this e-book to demonstrate and document problems with established and endangered sites. They include sites in nine countries, with eight protected and two endangered examples ranging in age from Ediacaran to Late Pleistocene.

Key Words: Paleoparks; fossils; conservation; parks.

Résumé : *Les Paléo-Parcs : Notre patrimoine paléontologique protégé et préservé sur site à travers le monde.*- Les gisements fossilifères mondiaux sont mis en péril par le développement économique, les constructions, les prélèvements et le vandalisme et ceci, bien que de nombreuses localités remarquables fassent l'objet de protections au titre du patrimoine mondial, par leur classement au titre de parc ou monument national ou régional, voire comme réserve à gestion étatique, associative ou privée.

L'Association paléontologique internationale (IPA) a monté une l'action "Paléoparcs" afin de protéger les sites menacés, faire l'inventaire et publier la liste des sites sauvegardés quelque soit leur statut, du moment qu'ils constituent une source primaire de données scientifique mais aussi d'information et de distraction du public. Cette liste concerne également, les lieux de présence de "fossiles vivants". L'IPA s'est donné 15 objectifs d'actions détaillés sur son site web où sont présentés les lieux protégés et ceux qui le mériteraient. L'IPA a parrainé des réunions et des ateliers lors de trois réunions internationales dans les cinq années écoulées pour exposer les problèmes, présenter des solutions et détailler ses objectifs.

Les dix exemples de paléoparcs présentés dans ce livre électronique couvrent l'intervalle de temps qui va de l'Ediacarien au Pleistocène supérieur. Chaque article expose les difficultés rencontrées et les solutions proposées pour la défense des sites menacés. Neuf pays sont représentés. Huit sites sont sauvegardés, deux encore en danger.

Mots-Clefs : Paléo-Parc ; fossiles ; préservation ; parcs.

Introduction

The paleontological field resources of the world are fast disappearing as development,

construction, industrialization, vandalism, and fossil harvesting by professionals, amateurs and commercial collectors continues. Small local sites to national or international areas that pro-

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tect paleontological treasures are essential, if we are to preserve and understand the history of life on Earth and to provide materials for scientific research now and in the future. The protection of fossil-bearing strata has a long history extending back hundreds of years, but much remains to be done and no worldwide effort to bring them all together has been attempted.



Figure 1: Miguasha World Heritage Site and Provincial Park, Canada. Visitor's Center including a museum showing specimens of Devonian fish and other organisms from the Park, as well as a history of the study of these.



Figure 2: Outcrops of fossiliferous marine sediments along the beach at Miguasha WHS and PP. The public is allowed to view the beds and watch on-going research excavations in the outcrops.

While a reasonably good job of preserving specimens in museums is done, this represents only one aspect of the data resources necessary to continue study of paleontological topics. Field sites provide other data that cannot be or is not commonly preserved in museums, such as sedimentary rock characteristics and structures, associated trace fossils, data from contiguous layers, and data collected by future techniques not yet available. In addition, these sites have values other than those associated with scientific research, including public and K-16 education, recreation, tourism, and even art and cooking.

In general people are interested in these kinds of places and are willing to support them on the local level because of the income, attention and educational opportunities that they generate. Most people would require professional guidance, but the value of fossils exposed on outcrops or in the ground is clear to most of them and to scientists.

Protected and endangered paleontologic sites

Many paleontologically-important field sites are already protected and conserved in a variety of ways—from international to national to local and even private levels. Many countries have recognized their paleontologic heritage by passing legislation against fossil collecting and some have preserved the best sites as parks or reserves. Likewise state, province and other local jurisdictions have also recognized the value of fossil deposits by protecting and conserving them in various ways. All of these are valuable PaleoParks and will be included on the IPA database for use by those people interested in finding accessible sites.

At the international level, UNESCO's World Heritage program (URL:

<http://whc.unesco.org/>), currently including 890 properties with cultural or natural heritage values, has recognized many paleontologically valuable sites (URL:

<http://www.worldheritagesite.org/categories/category11.html>). Among them are well-known sites such as Miguasha National Park in Canada (URL: <http://whc.unesco.org/en/list/686>, Figs. 1-2) revealing in exquisite detail Devonian fish and plants, Peking Man Site near Beijing, China (URL: <http://whc.unesco.org/en/list/449>, Figs. 3-5) where research and public viewings continue at an early human site, Wadi al Hitán (Whale Valley) in Egypt where numbers of Eocene whales (Figs. 6-8) detail the history of evolution of that group (URL:

<http://whc.unesco.org/en/list/1186>), the well-known Cambrian Burgess Shale (GOULD, 1989) included in the Canadian Rocky Mountain Parks preserves delicate fossils documenting the early radiation of animals (BRIGGS *et alii*, 1994), the Messel Fossil Pit in Germany (URL:

<http://www.worldheritagesite.org/sites/messelpit.html>) preserving a complete middle Eocene fauna and flora in remarkable ways (SCHAAL & ZIEGLER, 1992), and Lower Valley of the Awash in Ethiopia (URL:

<http://whc.unesco.org/en/list/10>) which has yielded the evidence of early human evolution including the famous fossil Lucy.



Figure 3: Peking Man World Heritage Site (1987) at Zhoukoudian near Beijing, China, includes a modern museum and giant sculpture of *Homo erectus pekinensis*, first described in 1929 as *Sinanthropus pekinensis* (BLACK, 1929). Ever since 1918, the caves and their deposits here have yielded many fossils and stone tools including those of *H. erectus pekinensis*, recently dated at .68 to .75 my (SHEN *et alii*, 2008) The site is also protected as a State Key Cultural Heritage Units under Protection, and, in 1983, the Beijing Municipal Government designated it as the Protection Area for Preservation of the Peking Man Site. The site is open and is well attended by the public and researchers in geology and paleontology.



Figure 4: The 1966 discovery site of a skull-cap of *Homo erectus pekinensis*, well labeled and available for inspection along the public trails in the site.

Protection of paleontological field resources varies enormously from country to country and even within single countries. While all are good, some are more effective than others. To date, countries (Ethiopia, Australia, China, United States, Canada, New Zealand, Mexico, France, Israel, and others) have moved to protect the scientific values of such areas, often as tourist attractions. Israel and Mexico have laws against disturbing any fossil site or fossils, while the U.S. protects vertebrate fossil sites, but not others on any of its federal lands except National Parks (URL: <http://www.nps.gov/>) where all resources are protected. The Geoparks System of Europe (URL: <http://www.europeangeoparks.org/issue/home/1%2C1%2C0.asp>) is a wonderful example of

parks providing the public with education, recreation, and entertainment, and sometimes participation in the scientific discovery of the history of our Earth. The concept has been expanded to a global network of 58 GeoParks recognized so far by UNESCO (URL: http://portal.unesco.org/science/en/ev.php-URL_ID=6400&URL_DO=DO_TOPIC&URL_SECTION=201.html). The network includes 34 European, 20 Chinese, 1 Brazilian, 1 Iranian, 1 Malaysian, and 1 Australian GeoParks; some are focused on paleontology while others include some fossil sites in their boundaries.



Figure 5: The public can view the Peking Man site over a series of trails that pass by the most significant historical and on-going research sites.

Likewise, the USA's 391 historical and natural National Parks and Monuments (URL: <http://www.nps.gov/>; for example, see Figs. 9-12), as well as some State Parks (for example California, URL: <http://www.parks.ca.gov/>, see Fig. 13) provide similar paleontological values with the opportunity to participate by camping, lectures, hiking, and research through the areas. Even in the countries with national programs, local governments, organizations and individuals also provide protected sites. In Mexico, particularly important sites are being protected by involving the local people as stakeholders who gain both recognition and financial benefits. Examples of fossil protection at the local level is common in the USA with places like Rancho La Brea, an endeavor of Los Angeles County Museum of Natural History, located on the exclusive Wilshire Boulevard in the City of Los Angeles. The tar pits and the George Page Museum (URL: <http://www.tarpits.org/>) exhibit Pleistocene faunas and floras (Fig. 14). This local county park preserves an amazing and most important deposit of Late Pleistocene fossils documenting the recent history of life in that part of Southern California for the general public and scientific community, even in the face of demand for the property along Wilshire. The pits and specimens catalogued in the Page Museum serve the general public and paleon-

tologic community very well. Dinosaur Ridge (Figs. 15-17), initiated and run by a non-profit group The Friends of Dinosaur Ridge (URL: <http://www.dinoridge.org/about/about.html>)



Figure 6: Wadi Al-Hitan (Whale Valley) World Heritage Site in the Western Desert of Egypt displays the remains of Late Eocene archeocete whales and other fossils, and protects the site for further research (see PETERS *et alii*, 2009).

near Denver, Colorado, is an example of a grass-roots organization acting to preserve a highly interesting and educationally-relevant field exhibit together with docents who provide on site educational discussions. This site protects more than just dinosaur footprints and fossils but impressions of mangrove trees, leaves, and burrows of invertebrates. Similar local sites occur and have been preserved in many other countries too. Near Puerto Natales, in Patagonian Chile, Cueva del Milodon Natural Monument contained the remains of the giant sloth *Mylodon darwini* discovered in 1896 (Fig. 18). The monument consists of several caves and other rock formations, with the fossils found in one of them and dated near 10,000 years ago (Late Pleistocene). It is now a tourist stop for many people.

As wonderful as these protected sites are, many more sites at all levels are endangered now or could be in the future. These places, except for those described in the chapters in this book, shall not be identified.



Figure 7: Vertical structures (burrows?) preserved at the Wadi Al-Hitan site. They range up to 1 m or so high and are exposed from the deposits by erosion of surrounding rock.



Figure 8: Public transportation is unusual at the Wadi Al-Hitan site.

The PaleoPark Initiative

The International Palaeontological Association (URL: <http://ipa.geo.ku.edu/index3.html>) began an initiative at the 30th International Geological Congress (IGC) in Beijing, China, in 1996 (LANE & BRUTON, 1996, 1998) to identify and protect important endangered paleontological sites. The IPA later expanded this initial demonstration effort to include all sites, preserved already or not, no matter their size or previous incorporation into other parks or preserves. Development of this initiative continued with presenta-

tions and workshops at the 32nd IGC (2004) in Florence, Italy, the 2nd International Paleontological Congress (2006) in Beijing, China, and the 33d IGC (2008) in Oslo, Norway. These events resulted in the selection of 10 examples of endangered and protected fossil sites across the world and a tentative list of objectives and procedures to be presented in this electronic book. IPA, representing international paleontology, is an important organization to lead this effort to conserve sites anywhere in the world, in order to provide guidance on their preservation and conservation.



Figure 9: The Thomas CONDON Visitor's Center at John Day Fossil Beds National Monument in Oregon, USA (URL: <http://www.nps.gov/joda/>), contains a gift shop, museum, preparation laboratory visible to visitors through glass windows, and research collections, library and space for researchers. The Monument is visited by tourists and scientists alike interested in seeing the Eocene to Miocene formations and fossils exposed in three different areas of east central Oregon.



Figure 10: John Day Fossil Beds National Monument Sheep Rock at the Condon Center displays the local stratigraphy. Although fossils are common in most rock units, no collecting is permitted although hiking on designated trails is.

The goals and objectives of the IPA PaleoParks Initiative are:

1. IPA's first goal is to develop the communication and organizational tools necessary for a worldwide preservation and protection effort. This process is underway at present as part of the PaleoParks Initiative.

2. IPA seeks to identify various paleontological field resources and tabulate the scientific, historic and tourist values of them. Such PaleoParks would contain significant paleontologic field resources, as defined by paleontologists, at the private, local, state, provincial,

national, or international level. The sites may already be protected in some way or may be threatened or endangered. IPA has called for professional paleontologists to identify both types of sites, but especially endangered sites, and these efforts continue. PaleoParks could also be living resources of significance to paleontologists or "living fossils", perhaps like the stromatolites in Shark Bay (Fig. 19) or the Redwood parks in California (Fig. 20), already a World Heritage Site.



Figure 11: The Hancock Tree, a permineralized tree trunk, preserved in a volcanic tuff deposited during the Eocene, is exposed in the Clarno Unit of the John Day Fossil Beds National Monument.



Figure 12: The Painted Hills, part of the Clarno Unit of the John Day Fossil Beds National Monument, is a sequence of Eocene paleosols that give the rocks their fantastic colors (RETALLACK *et alii*, 1999).



Figure 13: Red Rock Canyon State Park near Mojave, California, possesses an extensive badlands topography consisting of Miocene non-marine and volcanic deposits, some with mammal and other fossils (WHISTLER, 2005). In addition, historic sites, wildflower and wild animals may be viewed in the park. Miles of trails are available to the public for hiking or horseback riding, and off-road vehicles can use designated routes. Paleontological research is always underway in the park as the fossil biota continues to be documented and interpreted.

3. The nominations will be assessed by a committee of IPA and local paleontologists. In general, the local paleontologists, either professional or amateur, will approach IPA and they will work closely with IPA in developing the designation as a PaleoPark and later mechanisms for its protection.

4. If sites are unprotected, then jurisdictions and other stakeholders must be informed that scientists have identified their resource as valuable, and that their citizens, and people beyond their boundaries, are interested in the site and in the past life preserved there. The authorities might be informed that people are willing to visit the areas where they can view them, think they are in the midst of a working scientific site, and take pictures, at least. They should be informed of the recreational and educational values of the site as well as its scientific merits.

5. IPA will then work with jurisdictions to encourage them to protect areas identified as interesting and educational, as well as scientifically valuable, so that they are not degraded.

6. Criteria for the recognition of such sites should be established as a general guide. Such criteria have been suggested in the past for both geologic and paleontologic sites (ANDERSEN *et alii*, 1990; HAYWARD, 1996; JOHNSON & McCHRISTAL, 1997; JOYCE, 1994; LAPO, 1999, among others). The World Heritage Center and European GeoParks systems already have criteria.

7. A catalog of protected and endangered sites is now underway by IPA (URL: <http://ipa.geo.ku.edu/index3.html>), both as a resource guide and as examples of previous successful efforts. It will identify and tabulate all PaleoParks worldwide in a database, inclu-

ding established sites such as World Heritage Sites, GeoParks, National Parks, State and Provincial Parks, local parks or reserves, and private lands, and, importantly, new, undesignated sites that contain important fossils and field data especially if they are endangered. The database includes the usual identifiers but also the preservation and conservation status of the site, the goals for preservation and conservation, problems at the site either designated already or established. The database for endangered sites would be available on-line through passwords only. For established and protected sites, the database will be generally available as outreach to the educational communities and general public.

8. A general plan for the determination of sites that need to be protected worldwide should be drawn and supported. Neither a general catalog of preserved sites worldwide nor standardized criteria for the recognition of unprotected sites are yet finished, but they are goals of the IPA.

9. IPA will support PaleoPark activities and goals with expert advice and action to protect and conserve significant sites at an appropriate private, local, state, national, or international level.

10. IPA will identify and respond to problems at endangered sites, with appropriate expert opinion and advice to local authorities.

11. IPA can assist in the development of paleontological sites to enhance their educational, research and recreational uses. Some sites might support all three uses; others might be preserved just for research or education. Each site will be evaluated by experts.



Figure 14: Rancho La Brea, a local but very famous, fossil deposit lies along Wilshire Boulevard's Miracle Mile in Los Angeles, California, USA (URL: <http://www.tarpits.org/index.html>). The tar pits contain a Late Pleistocene fauna and flora. It is part of Hancock Park, owned by the County of Los Angeles, and the site is the type locality for the Rancholabrean North American Land Mammal Stage ranging from 300,000 to 11,000 years ago (URL: http://paleodb.org/cgi-bin/bridge.pl?action=displayInterval&interval_no=237). The George C. PAGE Museum, a branch of the Natural History Museum of Los Angeles County, is located in the park and provides public and educational displays and activities, as well as research facilities for professional paleontologists and geologists.



Figure 15: Dinosaur Ridge, near Denver, Colorado, USA, is a locally-operated site protecting a series of dinosaur tracks, mangrove impressions, and invertebrate trace fossils (URL: <http://www.dinoridge.org/visit/>). The ridge is designated a US National Parks Landmark and is protected and operated by a non-profit organization, The Friends of Dinosaur Ridge. A visitor's center with information, fanciful dinosaur models, and items for purchase marks the start of the drive or walk up the ridge to view the various fossils. A docent program provides on site guided tours and discussion of the fossils and rocks.

12. To provide general information on paleontological sites worldwide to those in positions of authority.

13. As an outreach activity to the general public and educational community, IPA will make available lists of fossil sites that offer supervised educational or recreational activities.

This would be online and not password protected. The sites included here would obviously be properly protected, officially designated and publicly available already. This is an official outreach and educational activity of IPA.



Figure 16: At Dinosaur Ridge, Colorado, the dinosaur trackways are protected behind an attractive fence and elevated viewing platform; other fossils are exposed in rocks along the length of the ridge.



Figure 17: Dinosaur trackways and other fossils at Dinosaur Ridge occur in the Cretaceous Dakota Group. The Late Jurassic Morrison Formation also exposed in the area has yielded many dinosaur fossils as well.



Figure 18: Cueva del Milodon Natural Monument, a unit of the Chilean National Park system, is located near Puerto Natales in southern Chile (URL: <http://www.gochile.cl/eng/Guide/ChileNationalParks/CuevadelMilodon/Cueva-del-Milodon-1.asp>). Skin, bones and dung of *Mylodon darwini* were discovered in the cave in 1896. Charles DARWIN earlier had collected a jawbone from Bahia Blanca, Argentina, during the cruise of the *Beagle* that was later described and named in his honor by Richard OWEN. Although the cave material is now dated at >10,000 years, for some time in the early 1900s, people searched Patagonia for live *Mylodon* based on the fresh appearance of the cave remains.



Figure 19: Stromatolites are "living fossils" that have been studied by many paleontologists. The image shows examples at Carbla Point, Shark Bay, Western Australia, also part of the Shark Bay World Heritage Site. See URL: <http://www.sharkbay.org/>.



Figure 20: Redwood forests are also "living fossils" worthy of preservation and study by paleontologists. Richardson Grove State Park, near Garberville, northern California. See URL: http://www.parks.ca.gov/?page_id=422.

14. IPA may enhance each PaleoPark by providing a "speaker's bureau" associated with it of experts who are also good speakers for outreach to the general public and educational organizations. It may also identify and provide literature on particular sites. This could include scientific, recreational, legal, administrative, and similar information.

15. IPA seeks to provide an image database related to PaleoParks for use by the various constituencies.

Contents of this book

In this book, examples of successful fossil site conservation are presented as are sites that have values worthy of saving but which are under threat for different reasons. The book consists of 10 examples, each of which explains the history of protection and development of the site, or of the threat to it, if it is not protected.

Four chapters present successful strategies and development of protected fossil sites. Bruce HAYWARD relates the efforts to preserve fossil and other geologic sites in New Zealand (HAYWARD, 1996), and the development of criteria and types of protection for sites, even with public collecting as one objective. The plan includes the identification, evaluation, protection, and acquisition or designation of sites aimed at their preservation far into the future. Likewise in Mexico, GAITÁN and ÁLVAREZ propose that a system of geological and paleontologic heritage sites in Baja California Sur that will be supported by local people who have a vested interest in them. The people will provide guidance and oversight for activities by the more than one million tourists that flock to that region for the beaches and resorts. While resorts provide entertainment and attraction for a short time, tourists often desire other experiences including visiting natural points of interest. Thus, an economic underpinning exists to maintain the level of support necessary to protect the sites. BOONCHAI and others document the development of fossil parks and museums (see LE LOEUFF, 2007) in Thailand, where a wide variety of fossils are protected in outdoor parks and museums especially for the education of the general public. SAMEENI presents an evaluation of the very large area of the Salt Range in Pakistan for PaleoPark development. This is the first step in protecting the valuable heritage sites in any region.

Individual sites already protected and the positive aspects of their operation as well as the problems they face are documented for Guanling in China (WANG), Haute-Provence, France (PAGÉS), and the Falls of the Ohio, USA (GOLDSTEIN). In each of these examples of preservation, a variety of fossil sites are described, each with different development histories and management approaches.

NYBORG describes a particularly difficult situation in Death Valley National Park in the USA where multiple sets of Pliocene trackways of many species of mammals and birds occur. In this case, the fossils are fragile and delicate and are weathering of their own accord, so that

special care must be taken to preserve them, even though they are already part of a protected area.

And lastly, two examples of unprotected and endangered sites are described, one threatened by individual unauthorized collectors and the other by industrial exploitation of fossil resources. FEDONKIN *et alii* describe a large area of the coastal White Sea in Arctic Russia where Vendian (Ediacaran) fossils, which have great value on the open fossil market, are being systematically pilfered. Stealing fossils is against the law there, but the area is so vast that enforcement is nearly impossible. The last example is of a Miocene forest of standing trees that are so fragile they disintegrate as soon as they are exposed to air. CSÁSZÁR and others show how the trees, preserved in anoxic lake environments, are being exposed and destroyed by lignite mining operations. Here the endangerment of the fossil forest is due to economic interests, and that poses a particularly difficult situation for saving the forest.

All of these PaleoParks are well worthy of continued or new protection and each presents different problems for paleontologists and natural resource managers. While fossil sites are being protected around the world, the diversity of fossils and field situations worldwide are enormous and are worthy of protection. Paleontologists will have to think creatively to achieve proper protection and conservation of these sites.

Acknowledgments

My interest in the protection and conservation of fossil sites was inspired by reading papers and the life of John C. MERRIAM (1869-1945), the first paleontologist appointed in 1896 to the University of California at Berkeley (URL: <http://www.ucmp.berkeley.edu/about/history/jcmerriam.php>). An early western North American paleontologist, he participated actively in the developing conservation movements in the west as a founding member of the Save the Redwoods League and an early member of the Sierra Club, and in the recognition of the potential as state or national parks of a number of paleontological sites, especially the John Day fossil beds in Oregon. MERRIAM pushed for the protection of these natural places as "inspirational" and educational sites that ordinary people could enjoy and learn from. He fought against the idea that such parks might become recreational objects without relevance for the natural values they preserved. In the face of the modern assault on the environment, his ideas are as important today as they were a century ago.

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at one of the meetings IPA sponsored or during the course of preparing their chapters. Javier GAITÁN MORÁN actually led me to sites in Baja California Sur that represent potential Paleo-Parks for a first-hand look at what he is doing there. I thank all of these people and more for contributing to this PaleoParks Program in their own ways.

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