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IN SEARCH OF THE LAST BEASTS OF THE ANIMAL KINGDOM. A STUDY BASED ON GEOGRAPHY AND HANDMADE DRAWINGS

ÎN CĂUTAREA ULTIMELOR BESTII DIN REGATUL ANIMALELOR. UN STUDIU BAZAT PE GEOGRAFIE ȘI SCHIȚE REALIZATE MANUAL

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Abstract: Large and powerful animals represent a source of fear and fascination for humans and influence the evolution of culture, civilization and science. Although the maximum size reached by such beasts has been the subject of intense controversy, little scientific interest has been given to distinguish reality from fiction. Therefore, the goal of our study was to identify the largest specimens of the contemporary mega fauna. In order to do so, we have a) selected the most representative species and identified the largest specimens through a scientific literature synthesis, b) reconstructed their distinctive physical features through detailed handmade drawings, and c) analyzed their location in relation to the distribution of reserves and intact ecosystems. Our results indicate that the maximum size reached by large water predators, such as sharks and crocodiles, has been much more documented compared to large land carnivores and herbivores. Almost all of the exceptionally large specimens identified were located in protected areas. In several cases, such as the Indian elephant (*Elephas maximus*) and the saltwater crocodile (*Crocodylus porosus*), the largest individuals have been identified in the last couple of decades. The results represent a true statement concerning the importance of preserving mega fauna species, and reveal that, despite increasing human population and pressure over the natural environment, the beast of the animal world can still survive in modern times, due to the conservation of large wild habitats through networks of protected areas.

Key-words: *mega fauna, exceptional specimens, protected areas, intact ecosystems.*
Cuvinte cheie: *mega faună, exemplare excepționale, arii protejate, ecosisteme intacte.*

1. INTRODUCTION

From prehistoric times, animals reaching impressive sizes have been a subject of fascination and have influenced human culture or folklore and generated intense scientific debates. The fascination for finding the biggest specimens was the goal of both scientists and pioneer adventurers or explorers. Claims of giant

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reptiles or fish have been honestly described in various difficult to access or scarcely explored regions of the globe (Whitaker & Whitaker, 2008). Literature is often filled by numerous exaggerated and unverified information regarding the size of such beasts, and it is the goal of scientists to distinguish fact from fiction (Bouletreau & Santoul, 2016).

Within the animal kingdom, few species have generated such interest in identifying the largest specimens, as in case of mega-fauna. The most common examples include large land carnivores, especially felids and bears, respectively mega herbivores, such as pachyderms and bovines. A third representative category refers to great water carnivores, namely sharks and crocodiles (Malhi et al., 2016). Particularly interesting are the mega fauna species which based on their diet habits, pose a direct threat to humans, namely large carnivores, and which have given birth to numerous legends and myths due to their perception in popular folklore as vicious man-eaters, being considered responsible for exaggerated numbers of human fatalities. The most notorious of them were depicted as particular specimens, which seemed to develop a taste for human flesh and, consequently, hunted humans with premeditation (Rani & Kumar, 2017).

Due to the fear, they posed over humans, claims regarding their size have been exaggerated, being extremely difficult to split reality from myth. The first well documented cases were registered in the medieval period and refer to the wolf of Gevauden, an exceptionally large specimen of grey wolf (*Canis lupus*), considered responsible for killing numerous people in France between 1764 and 1767, and described as being the size of a donkey by numerous manuscripts of that time (Taake, 2020). Similarly, in 1842, the publication Gazette d'Augsburg notes the presence of grey wolves the size of mules, which devoured couriers in their attempt to pass the Carpathian Mountains from Valahia to Transylvania (Vărzaru, 1984). Besides large carnivores, another group of mega fauna species characterized by numerous debates concerning the realism behind estimates of enormous sized specimens, are the large land herbivores (Owen-Smith, 1988). Similarly, to carnivores, known for their abominable aura, the great herbivores are responsible for high numbers of human fatalities especially do their size and bad tempered. The fear and fascination generated by these conflict interactions are one of the reasons for which estimates regarding their size are commonly overrated, as in the case of elephants, rhinoceros, hippopotamus and buffalos (Marchini, 2014). Secondly, many large land herbivores have habitats in poorly developed countries from the tropics, where, based on the lack of accurate scientific data, it is hard to identify the true maximum size reached by remarkable specimens.

Identifying, studying and conserving exceptional large mega fauna specimens it is crucial, because animals reaching great sizes are extremely rare or even unique and possess a high conservation value. Also, these specimens have cultural value, by representing elements of identity and heritage for different communities, and are the subjects of intense scientific interest, since their study could provide vital clues for developing a better coexistence between people and mage fauna (Bouletreau & Santoul, 2016). Mega fauna uses size and physical abilities to hunt, access food resources, reproduce or fight with rivals over territories. Complementary, these are

some of the species characterized by the most intense conflict historical pattern of interaction with humans (Malhi et al., 2016). In developed countries, where competition for space and resources is intense between humans and large animals, increasing human activities and population have led to the extinction from the wilderness of large herbivores, such as the case of the European bison (*Bison bonasus*) (Kowalczyk et al., 2013). Also, several other species, especially the notorious large carnivores, were almost brought to extinction by human persecution due to fear and false misbeliefs (Rani & Kumar, 2017).

Despite the numerous conflicts between people and large animals, consistent populations of mega fauna still manage to survive in modern times in various habitats, especially in terrains very difficult to access by humans, or by contrast, in human dominated landscapes with well-connected networks of protected areas (Chapron et al., 2014). Therefore, in order to preserve mega fauna effectives and exceptional specimens, it is vital to identify and understand the geographical characteristics that allowed them to survive even in the contemporary period, when human pressure over natural habitats reaches the historical peak. Scientific studies are usually directed towards assessing the physical parameters of exceptional mage fauna individuals (Lister & Blashford-Snell, 2000; Britton et al., 2012), and do not take into account the influence of landscape characteristics that may allow the specimens to reach such great sizes. Based on the stated aspects, the goal of our study was to explore if remarkable specimens of mega fauna are still found in modern times, and the objectives are: O1 to select the most representative mega fauna species and to identify the largest specimens scientifically validated, and O2 to analyze their location in relation to the spatial distribution of reserves and wild areas.

2. DATA AND METHODS

We have included in our study area (Fig. 1) ecosystems from various regions of the planet, in order to encompass habitats for a wide range of mega fauna species: a) the tropical and subtropical coastal waters of Australia and Brazil, which are primarily habitats for large predatory fish (Last & Stevens, 1991; Barreto et al., 2017); b) the savannahs of South-Eastern Africa (South Africa and Zambia), respectively South Asia (Nepal), which shelter the largest population of pachyderms from the planet (elephants, rhinoceros and hippopotamus) (Owen-Smith, 1988); c) the wetlands of South East Asia (Philippines), one of the main habitats for the world's largest reptile, the saltwater crocodile (*Crocodylus porosus*) (Britton et al., 2012); d) the tundra from North America (Canada), home to the largest effectives of polar bears (*Ursus maritimus*) (Amstrup, 2003); e) the temperate river ecosystems of Western Europe (France), which shelter one the largest freshwater fish, the European catfish (*Silurus glanis*) (Bouletreau & Santoul, 2016); f) the temperate forests of the northern hemisphere, known for the large populations of carnivorous mammals, such as grizzly bears (*Ursus arctos horribilis*) in USA (Schwartz et al., 2003), and Amur tigers (*Panthera tigris altaica*) in Russia (Pikunov et al., 2010); and g) the temperate forests of Central Europe (Poland), the land of the world's largest population of European bison (Kowalczyk et al., 2013).

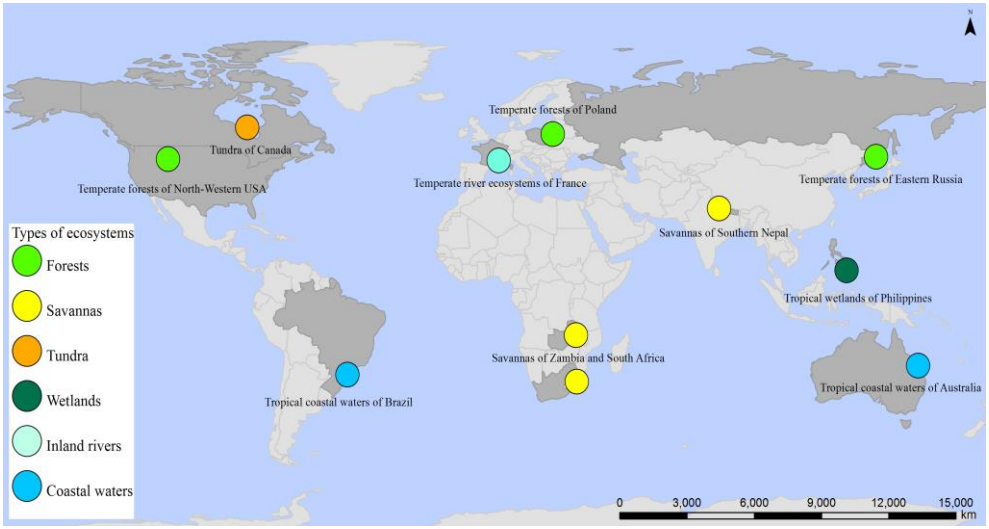


Fig. 1 The ecosystems included in the study area
(Data source: Hengl et al., 2016)

In order to conduct O1 we have selected the most representative species of mega fauna, identified the largest specimens, and graphically reconstructed them through realistic handmade drawings.

The first step of our study was to select the most iconic species of mega fauna, based on a couple of criteria: a) the species must be characterized by a mythical aura and their great size must be subject of legends, tales and unverified claims; b) the maximum size reached by the species must represent an intensely debated subject in the scientific environment; c) the selected species must have a charismatic character and a strong cultural significance for the evolution of human society (Bouletreau & Santoul, 2016); and d) the species must be some of the largest from the three main groups of mega fauna - water carnivores, land carnivores, and land herbivores. Therefore, in case of large land predators, we have selected the largest members of the bear's family, namely the grizzly bear and the polar bear, respectively the largest feline, the Amur tiger (Pikunov et al., 2010). We preferred the two bear species, since there is a constant scientific debate regarding the largest member of the group, between the polar bear and several brown bear subspecies, especially grizzly bear, Kodiak bear (*Ursus arctos middendorffi*) and Eurasian brown bear (*Ursus arctos arctos*) (Soibelzon et al., 2011). We have taken into account several large aquatic predators, such as the great white shark (*Charcharodon charcharis*) and the tiger shark (*Galeocerdo cuviere*) – the two largest oceanic predatory fish (De Maddalena et al., 2003; Meyer et al., 2014), respectively the European catfish – Europe's largest predatory freshwater fish (Bouletreau & Santoul, 2016), and the saltwater crocodile - the world's largest living reptile (Britton et al., 2012). In case of mega herbivores, we have selected some of the largest land mammals – the Indian elephant (*Elephas maximus*), the white rhinoceros (*Cerathotherium simum*), and the common hippopotamus (*Hippopotamus amphibious*) (Owen-Smith, 1988). Despite the fact

that the African elephant (*Loxodonta africana*) is widely regarded as the largest land mammal, several individuals of giant Indian elephant bulls from Nepal are known to have reached unusual large sizes, being possibly the largest elephants recorded in modern times (Lister & Blashford-Snell, 2000). We have included in the study the European bison (*Bison bonasus*), one of the world's largest bovid (Krasiñska & Kransiñski, 2002; Kowalczyk et al., 2013).

The second step was to identify the largest specimens scientifically validated, by cross-referencing the available zoological, biological and ecological literature. The selected specimens had to fulfill several criteria, in order to be taken into account in our assessment, such as: a) the measurements concerning their physical parameters had to be performed by specialists and published in scientific researches; b) their physical parameters had to be the results of accurate and detailed measurements of the original specimens, not estimates, incomplete data or statistic models; c) the data collected had to be as recent as possible, and new data was preferred over older information, since the measurements were performed with advanced technical equipment; and d) the studies had to reveal values concerning common morphometric indicators, especially weight, length (usually for water carnivores), and height (namely for land herbivores). The weight of the specimens was the single most common, and therefore, most important indicator used in our study, since it was collected for all of the species. The length of the animals (from nose to tail) was preferred because it is a common parameter used especially in order to characterize the size of large reptiles (Britton et al. 2012) and fish (Holmes et al., 2012; Amorim et al., 2017). In case of land carnivores and herbivores, the shoulder height was another significant parameter, and it was collected for the Indian elephant (Lister & Blashford-Snell, 2000) and common hippopotamus (Marshall & Sayer, 1976). For some species, such as the great white shark (Amorim et al., 2017), Indian elephant (Lister & Blashford-Snell, 2000), and white rhinoceros (Hillman - Smith et al., 1986), we were forced to take into account estimated values for their weights, since there was no accurate data available.

The third step is represented by the realistic graphical reconstruction of the selected specimens, in order to evidence their distinguishable physical features. The use of realistic drawings has been a common approach, suitable for promoting biological research and biodiversity conservation (Quillin & Thomas, 2015; Thomas-Walters et al., 2020). For our drawings, we have relied on: a) photos, images or even casts exposed at museums of the original specimens, if available; b) other images or graphic reconstructions of similar sized individuals; c) our own personal observations of exceptionally large specimens from zoological gardens and reserves. Only in case of the great white shark (Amorim et al., 2017), saltwater crocodile (Britton et al., 2012), Indian elephant (Lister & Blashford-Snell, 2000), and Amur tiger (Valvert, 2009), we were able to reconstruct the specimens by using as a source of inspiration photos or preserved models with the original individuals. For the common hippopotamus and European bison, we used as a source of inspiration our personal observations of other very large specimens from zoological gardens or protected areas. For the rest of the species, we relied on other

images, drawings or casts with other large specimens, especially from encyclopedias ("Arborele Lumii" encyclopedia, 2000) and scientific books (Owen-Smith, 1988; Amstrup, 2003). The graphic reconstructions were represented by highly detailed and realistic non-colored handmade drawings, since we wanted to evidence the remarkable physical features of the specimens. None of the graphical representations is made on a scale in relation to the others, because it would have been difficult to represent together animal species characterized by extremely pronounced differences in size.

Lastly, we have developed a table, encompassing the main characteristics of the largest specimens of mega fauna scientifically validated - Species or subspecies/ Gender/ Specimen name/ Size and weight measures/ Distinctive morphological features/ Year of measurements/ Location/ Scientific source/ Graphic reconstruction/ Source of inspiration, representing Result 1.

In order to conduct O2 we have analyzed the geographical location of the selected specimens, in relation to various spatial indicators, which reflects the presence of high conservation value ecosystems.

The first step was to identify the geographic location of the selected specimens and to develop a vector database with the specific locations. Since none of the studies regarding the size of the specimens provided the accurate geographical coordinates of the points where the animals have been captured or observed, we were forced to rely on their approximate location. Many of the targeted individuals were identified inside a protected area (especially in case of land carnivores and herbivores) (Lister & Blashford-Snell, 2000; Valvert, 2009), in the proximity of a coastline (for the great white shark and the tiger shark) (Holmes et al., 2012; Amorim et al., 2017), or within an inland river (for the European catfish) (Bouletreau & Santoul, 2016).

The second step was to select several spatial datasets, which mark the presence of high naturalness areas and wild habitats. We have preferred the global network of protected areas dataset (Protected Planet, 2021), since protected areas could prove a crucial form of durable spatial management, which may favor the preservation of mega fauna and diminish conflicts with humans. Furthermore, we have selected the intact ecosystems dataset (Watson et al., 2018), since it can help us understand if the presence of large continuous patches of wilderness could represent a vital factor for the survival of mega fauna. Also, we have included in our assessment the river basin fragmentation dataset (Nilsson et al., 2005), due to the fact that several of the targeted species (as the saltwater crocodile, European catfish and common hippopotamus) had their habitats in inland water flows, and the degree of human pressure over these ecosystems could represent one of the factors that allowed them to reach such great sizes.

For the last step, we have superimposed the geographical location of the specimens over the three datasets, and created a map which evidences the geographical features that influence their spatial distribution, representing Result 2.

3. RESULTS AND DISCUSSIONS

The first result R1 (according to O1) is represented by a table encompassing information regarding the largest specimens scientifically validated from the targeted species (Table 1). The second result R2 (according to O2) is represented by a map which highlights the geographical location of the specimens in relation to the spatial distribution of protected areas, intact ecosystems and river basin fragmentation due to anthropic infrastructures (Fig. 2).

The great white shark has been the most intensively studied mega fauna species in terms of maximum size reached by giant specimens. The most significant individuals were several females caught in the Mediterranean Sea near the shores of Jabuka Island, Croatia, in the year 2003 (total length: 570 cm) (Soldo & Dulcic, 2005), and Sette, France, in the year 1956 (total length: 589 cm) (De Maddalena et al., 2003), respectively in the Atlantic Ocean, near Bom Abrigo Island, Brazil, in the year 1992 (total length: 530 cm) (Amorim et al., 2017). The specimen from Brazil was the only one accurately measured. All of the three females had an estimated weight ranging between 2 and 2.5 tones. The coastal seas of France are areas of intense human pressure over the environment, especially due to tourism activities and commercial fishing. Yet, the presence of giant sharks in the proximity of dense tourist areas evidences that very large predators can coexist alongside humans even in modern human dominated landscapes. In case of Brazil, the large female was caught near the Abrigo Island, which is included in the Ilhas do Abrigo e Guararitama Wildlife Refuge. By comparison with the great white shark, the maximum size reached by the tiger shark has not been such an interesting scientific topic, feature possibly justified by the fact that this species does not wield such fascination. The tiger shark is still a massive predatory fish, the largest size being reached by a female caught in Australia, near the Capricorn Coast, between the years 1993 and 2010 (total length: 550 cm) (Holmes et al., 2012). The entire North-Eastern coast of Australia, one of the world's best habitats for the species, is protected under the Great Barrier Reef Marine Park.

In case of the European catfish, the largest specimen identified was caught in the Rhone River of Southern France, in the year 2015 (length: 273 cm, weight: 130 kg) (Bouletreau & Santoul, 2016). Despite being highly modified by human intervention, the Rhone River still holds some of Western Europe largest wetlands, due to its partially wild delta, protected under the Camargue Ramsat site. Yet, there is no scientific evidence that this specimen was caught inside this protected area. Specimens of similar size were fished in other highly fragmented rivers systems, such as the Po River from Italy and the Danube River in Romania (Bouletreau & Santoul, 2016).

The largest saltwater crocodile ever measured was "Lolong", a giant male caught in the Agusan swamps of Mindanao, Philippines, in the year 2012, which lived in the proximity of several isolated villages, being responsible for killing large domestic buffalos (length: 617 cm, weight: 1075 kg) (Britton et al., 2012). Mindanao still holds wild swamps in the Agusan River Basin, one of the world's largest water flows which is not affected by the fragmentation of dams. All of these

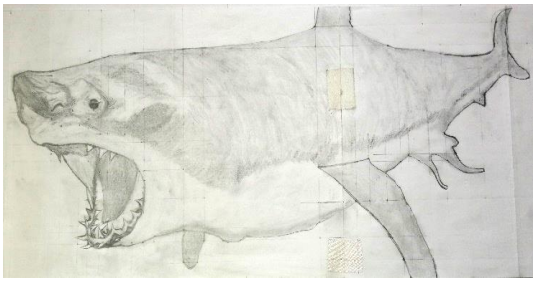
factors contribute to the survival of this massive predator in modern times, near humans. There is a consistent amount of scientific evidence of even larger crocodiles, even if none of them are accurately measured. Ziegler et al. (2019) discusses the finding of a giant crocodile skull from Southern Vietnam in the year 2010, indicating that the specimen had an estimated total body length varying between 630 and 680 cm. Whitaker & Whitaker (2008) record the presence of a massive male caught in the swamps of the Fly River, in Papua New Guinea, in the year 1980. The specimen had a length of approximately 620 cm. Another giant, kwon as "Khalia", was shot in the year 1926 near the banks of the Dhamra River, Bhitarkanika National Park, Orissa, India, and was described as having a length of almost 7 meters (Whitaker & Whitaker, 2008).

According to Valvert (2009), the largest Amur tiger was measured in the year 1992, within the Sihote Alin Biosphere Reserve, (206 kg), one of the last remaining wilderness of Eastern Russia. The reserve protects large intact forested landscapes, which represent high quality habitats for elusive carnivores (Potapov et al., 2008). However, even inaccessible areas are affected by habitat fragmentation and wildlife poaching, the result being the fact that the size of modern Amur tigers has reduced drastically. Older historical records reveal that, in extremely rare cases, males could have reached even greater sizes. Sunquist & Sunquist (2002) describe an invalid estimate of a massive 320 kg specimen, whereas Slaght et al. (2005) indicate the presence of a 254 kg male. In case of the grizzly bear, the largest specimen on record is a male weighting 500 kg, which was studied in the Yellowstone National Park, Wyoming, USA, between the years 1959 and 1970 (Craighead & Mitchell, 1982). Similarly with the size reached by very large grizzlies, old hunting records notice the presence of over 400 kg brown bears shot in the Carpathian Mountains of Romania, in the County of Harghita, yet with no scientific basis (Cotta & Bodea, 1969). More realistically, Swenson et al. (2007) indicate that the largest male measured in the Carpathian Mountains was identified in Slovakia and weighted 328 kg. Yellowstone National Park protects some of the largest intact forested ecosystems from continental USA, except Alaska (Potapov et al., 2008), whereas the Carpathian Mountains are known for their old growth temperate forests (Biriș & Veen, 2005). The results highlight that, in order to reach massive sizes, large land carnivores prefer wild habitats, with minimal human intervention. As for the polar bear, a massive 654 kg specimen was studied in Canada, Ontario, in the Sothern Hudson Bays Polar Bear Provincial Park (Kolenosky et al., 1992), an area which shelters some of America's largest pristine tundra ecosystems. Non verified estimates indicate the presence of specimens weighting 800 kg in Alaska, USA (DeMaster & Stirling, 1981).

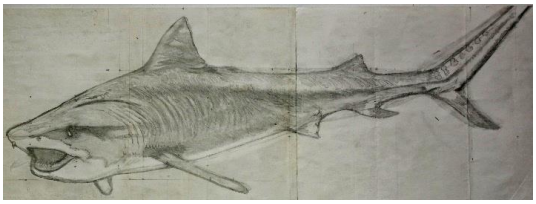
In case of land herbivores, we have noticed that few studies analyzed aspects concerning the maximum size reached by exceptional specimens. The Indian elephant, which reached the largest size, was a giant male from Royal Bardya National Park, Nepal, known as "Raja Gaj" (shoulder height: 343 cm) (Lister & Blashford-Snell, 2000). Due to its primeval appearance, it was supposed that he was a prehistoric stegodont or some king of a genetic freak, a possible mutant

version of today's Indian elephants (Roesch, 1995). Further studies revealed that "Raja Gaj", and several other giant bulls from the park, were just exceptionally large specimens of modern Indian elephants. The largest hippopotamus was identified during culling procedures in the Luangwa National Park, Zambia, between the years 1970 and 1972 (shoulder height: 147 cm, weight: 1790 kg) (Marshall & Sayer, 1976), whereas the largest specimen of white rhinoceros was a male from the Hluhluwe-Imfolozi Game Reserve, South Africa, which in the year 1965 was estimated at a weight of 2130 kg (Hillman-Smith et al., 1986). For the European bison, Krasiñska & Kransiński (2002) mention the presence of a 920 kg male, caught and measured in the Bialowieza National Park of Poland, in the year 1988. For all of the four species of land herbivores, the selected specimens were located in protected areas. However, none of them had their habitats in regions with intact ecosystems. Royal Bardya Park shelters some of the last relicts of the once primeval forests and grasslands which covered the Terai Plane, and increasing human pressure has affected the natural ecosystems and triggered conflicts with elephants. Bialowieza National Park is a remnant of the continuous old growth forests that covered much of the Northern European Plain. Hluhluwe-Imfolozi Game Reserve and South Luangwa National Park preserve scarce relicts of the once mighty savannas which were scattered over the South African plateaus and plains (Hengl et al., 2018). Similarly, despite being severely fragmented, the Luangwa River shelters the largest population of hippopotamus from the planet (Marshall & Sayer, 1976). By opposite to land carnivores, the results revel that large herbivores can reach exceptional sizes even in human dominated landscapes.

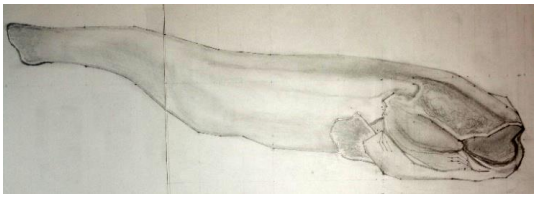
Table 1 The characteristics of the largest specimens scientifically validated within the selected species of mega fauna

Species or subspecies / Gender/ Specimen name/ Size and weight measurements/ Remarkable morphological features/ Year of measurements/ Location/ Scientific source/ Graphic reconstruction source of inspiration	**Graphic reconstruction**
Great white shark (*Charcharodon characharis*)/ Female/ Not the case/ Total length: 530 cm, estimated weight: 2500 kg/ Bulked body, wide jaws/ 1992/ Bom Abrigo Island, Brazil/ Amorim et al., 2017/ Reconstruction after a) a picture of the original specimen (Amorim et al., 2017) and b) our own personal observations of a massive specimen caught near Zanzibar, Tanzania, and exposed at the "Grigore Antipa" Museum of Natural History from Romania	

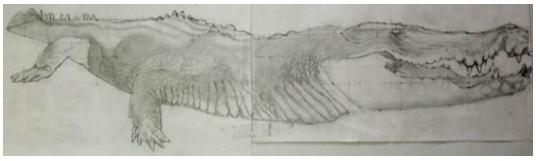
Tiger shark (*Galeocerdo cuviere*)
Female/
Not the case/
Total length: 550 cm/
Unclear spot pattern, flat head, wide jaws/
1993 – 2010/
Capricorn Coast, Australia/
Holmes et al., 2012/
Reconstruction after a) a large female tiger shark picture ("Arborele Lumii" encyclopedia, 2000), and b) a picture of a very large specimen caught by Walter Maxwell in 1964, Myrtle Beach, South Carolina, USA (Braswell, 2008).



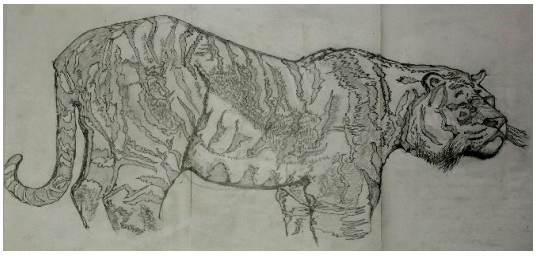
European catfish (*Silurus glanis*)
Not specified/
Not the case/
Total length: 273 cm, Weight: 130 kg/
Flat head, wide jaws/
2015/
The Rhone River, France/
Bouletreau & Santoul, 2016/
Reconstruction based on our own personal observations of a giant European catfish specimen caught in the Danube Delta, Romania, and exposed at the "Grigore Antipa" Museum of Natural History from Romania



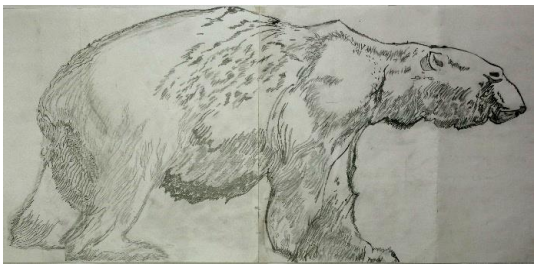
Salt water crocodile (*Crocodilus porosus*)
Male/
"Lolong"/
Total length: 617 cm, Weight: 1075 kg/
Bulked body, wide jaws/
2011/
Bunawan, Philippines/
Britton et al., 2012/
Reconstruction after a picture of the original specimen, exposed at the National Museum of Natural History, Manila (Gascon, 2018)



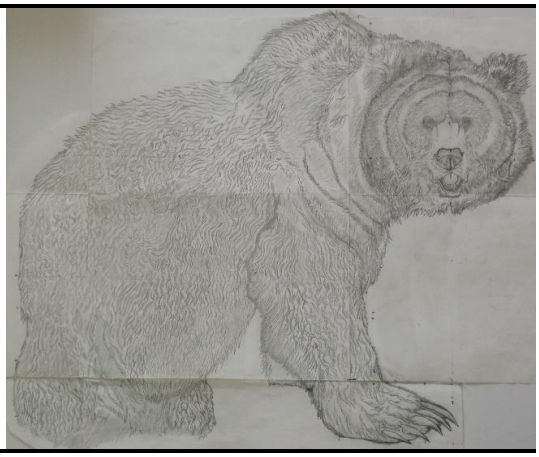
Amur tiger (*Panthera tigris altaica*)/
Male/
206 kg/
Muscular upper body/
1992/
Sikhote – Alin Biosphere Zapovednik, Russia/
Valvert, 2009/
Reconstruction after a) a picture of the original specimen (Valvert, 2009), and b) a drawing by Macrea (1958)



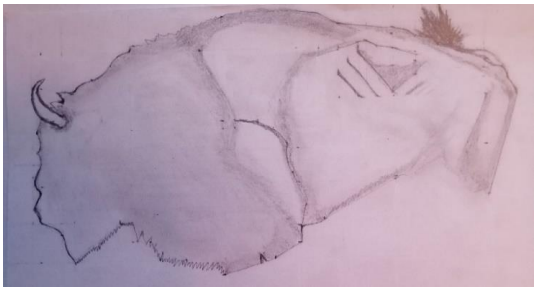
Polar bear (*Ursus maritimus*)
Male/
Not the case/
654 kg/
Long neck, wide paws/
1984-1988/
Southern Hudson Bay, Canada/
Kolenosky et al., 1992/
Reconstruction after a) the picture of a very large male (Amstrup, 2003), and b) a drawing by Macrea (1958)



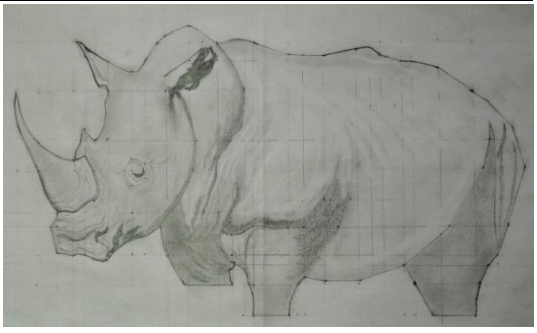
Grizzly bear (*Ursus arctos horribilis*)/
Male/
Not the case/
500 kg/
Massive back hump, wide paws/
1959 – 1970/
Yellowstone National Park/
Craighead & Mitchell, 1982/
Reconstruction after a) a detailed drawing of a large male ("Arborele Lumii" encyclopedia, 2000), and b) the picture of an exceptionally specimen, hunted by Robert Steed, in the year 2013, near Sleetmute, Alaka, USA (McAdams, 2017)



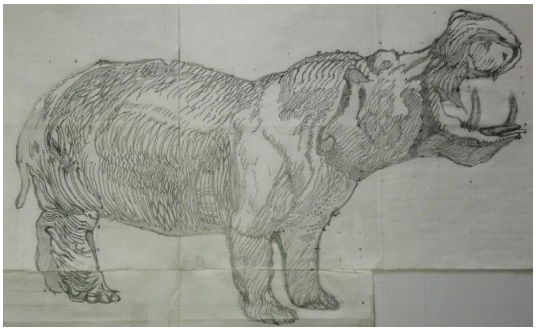
European bison (*Bison bonasus*)
Male/
Not the case/
Weight: 920 kg/
Massive back hump, prominent chest, thick and heavy fur/
1988/
Bialowieza National Park, Poland/
Krasińska and Kransiński, 2002
Reconstruction after a) a picture of a large male from the Bialowieza National Park ("Arborele Lumii" encyclopedia, 2000), and b) our own personal observations of the largest specimen from the Neagra Forest Reserve, Romania



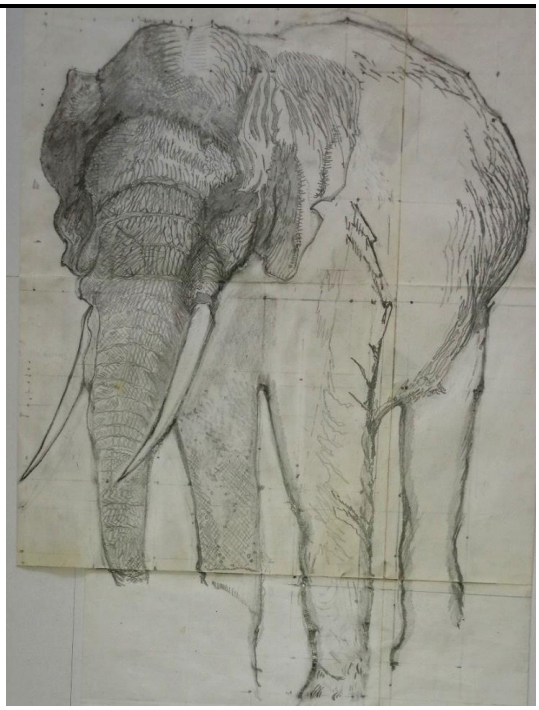
White rhinoceros (*Ceratotherium simum*)
Male/
Not the case/
Weight: 2130 kg/
Long curved horn, massive neck hump/
1965/
Hluhluwe-Imfolozi Game Reserve, South Africa/
Hillman-Smith et al., 1986/
Reconstruction after the pictures of two old males ("Arborele Lumii" encyclopedia, 2000; Owen-Smith, 1988)



Hippopotamus (*Hippopotamus amphibious*)
Male/
Not the case/
Shoulder height: 147 cm, Weight:1790 kg/
Long curved tusks, massive neck hump/
1970 – 1972/
South Luangwa National Park, Zambia/
Marshall & Sayer, 1976/
Reconstruction based on a) our own personal observations of one of the largest captive hippopotamus from Europe, an old male named "Cooper", living at the Zoological Garden of Călărași, Romania, and b) a drawing by Macrea (1958)



Indian elephant (*Elephas maximus*)/
Male/
"Raja Gaj" ("King Elephant")/
Shoulder height: 343 cm, Footprint diameter: 57 cm/
Preeminent high frontal head domes, long curved tusks/
1991-1999/
Royal Bardia National Park, Nepal/
Lister & Blashford-Snell, 2000/
Reconstruction after a) a photo of the "Raja Gaj" Indian bull elephant made by John Blashford-Snell, b) seven other high domed giant bull elephants identified in the Royal Bardia National Park of Nepal, with the names of "Bahadur Gaj", "Beli Chor", "Deep Gaj", "Bhim Gaj", "Kansha", "Tul Gaj" and "Tula Hatti" (Lister & Blashford-Snell, 2000), and c) a drawing by Macrea (1958)



(Source: Mustățea Mihai 2021)

4. CONCLUSIONS

Our results indicate that the maximum size reached by exceptional mega fauna specimens exerts a higher scientific interest and it is much better documented for water carnivores (sharks and crocodiles), than for land carnivores and land herbivores.

The water carnivores were the only mega fauna species for which all of the selected specimens were identified in the last 10 – 20 years, indicating that very large predators can manage to exist even in modern times, despite the increasing human population and economic exploitation of natural resources.

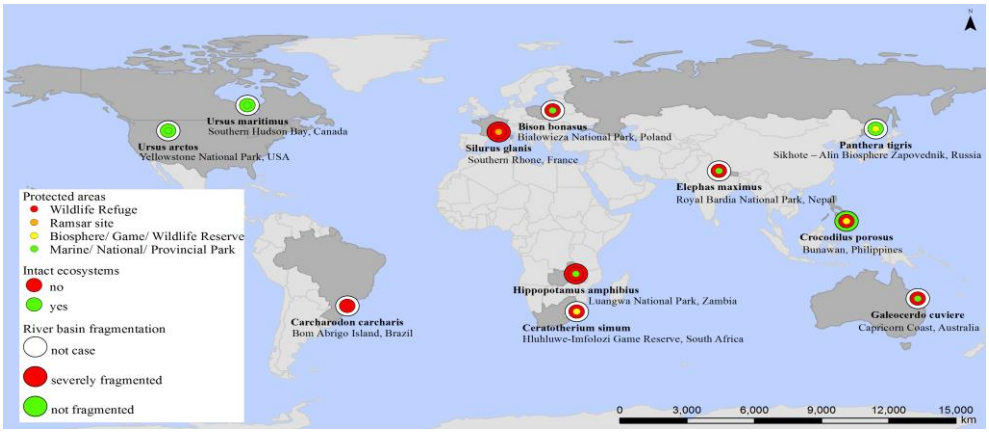


Fig. 2 The geographical location of the largest mega fauna specimens scientifically validated, in relation to the distribution of protected areas, intact ecosystems and river basin fragmentation

(Data source: Nilsson et al., 2005; Protected Planet, 2021; Watson et al., 2018)

The majority of the identified specimens were located in protected areas, and especially in national parks, relevant evidence concerning the influence of natural reserves on conserving exceptional mega fauna individuals. The land carnivores were the only mega fauna located in areas with intact natural ecosystems, highlighting that these species are much more sensitive to human pressure and need large compact pockets of high-quality habitats.

The saltwater crocodile was the only mega fauna specimen located in an unfragmented river basin, revealing that inland water courses fragmentation may have greater effect on the ability of this predator to reach remarkable dimensions. On the contrary, the hippopotamus is an example of mega fauna that could still thrive and reach an impressive size, despite the fact that its habitat lies in severely fragmented rivers systems.

Overall, the assessment reveals that, despite increasing human pressure over the environmental resources in modern times, on the planet, there are still remaining large wild areas, which could allow animals to reach great sizes, and conserving these last pockets of wilderness through protected areas is efficient in order to favor the survival of mega fauna.

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