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Veterinarian's Role in Conservation Medicine and Animal Welfare

*Diana Raquel Neves Fernandes
and Maria de Lurdes Ribeiro Pinto*

Abstract

The enhanced role of human actions brings new escalating conservation challenges and emerging diseases, which pressure impaired long-term survival of threatened free-ranging and captive wildlife species, while having hazardous effects on ecosystems and public health. Veterinarians have not only a broad education in comparative medicine (not a single-species focus) but also are also highly trained in recognizing, diagnosing and understanding disease impact on public health as well as on individuals, populations and whole ecosystems. Their skills and expertise turns them into valuable key players in planning, implementing and effectively assisting both in-situ and ex-situ conservation projects. In parks and zoological gardens, major goals have now won priority: the conservation of worldwide fauna and flora and the protection of animal welfare. Today, animal welfare can be scientifically assessed to determine the quality of life of individuals, in which behavioral assessment and behavioral enrichment are fundamental tools.

Keywords: veterinary, conservation medicine, zoological institutions, animal welfare, animal behavior, behavioral enrichment

1. Introduction

Current extinction rates are outstandingly high (about 1000 times previously valued ones) and likely to be underestimated once biodiversity statistics are affected by a gap of information on species taxonomy, distribution and status [1]. The enhanced role of human actions brings new escalating conservation challenges and emerging diseases, which pressure impaired long-term survival of threatened free-ranging and captive wildlife species, while having hazardous effects on ecosystems and public health [2–4]. Biodiversity conservation currently requires a broader approach, capable of connecting interdisciplinary bridges between the diversity of social, economic, political and biological variables which influence health issues, so to understand their complex interaction and therefore find new solutions bearing in mind human and animal well-being while preserving ecosystems, in what is designated as the “OneHealth” approach. Zoological and wildlife medicine are acknowledged scientific branches within the veterinary profession, which emerged in the 1990s as a response to increasing concerns regarding wildlife protection, and that now fully integrate the transdisciplinary frame that characterizes Conservation Biology [2]. Wildlife veterinarians and the zoological community have a pivotal role to play in the future of biodiversity conservation as, apart from saving numbers of species and understanding

the consequences of animal diseases to human communities, they also encompass the protection of functional and integrated ecosystems, applying their skills and scientific knowledge on the emerging field of Conservation Medicine [5, 6].

Modern zoos and aquariums have a responsibility towards the animals under their protection, through their whole life stages. Captivity can affect drastically animal behavior. By confining animals to a cage or enclosure, we reduce the complexity of their environment, severely narrowing the natural control they should detain over it and restricting the range of behaviors they are able to exhibit [7]. Where animals have very limited choices we are the ones planning almost all aspects of their life (e.g., feeding schedules, what to eat, where to sleep, who to live or to reproduce with). Effects of sensory deprivation and physical variety in the environment may result in aggression, boredom, anxiety, frustration and, ultimately, both physical and physiological illness [8]. Furthermore, preservation of core biological behaviors is essential [to the survival of the individuals targeted for release and reintroduction in the wild and, therefore, for the success of conservation programs [9]. Thus, captive establishments have an ethical and legal obligation to provide for the holistic welfare of all animals under their protection. They should work in an organized way in order to achieve high standards of animal welfare (AW), comply with animals' wide range of needs and minimize the incidence of negative states while promoting positive ones [10]. This involves providing: (1) appropriate, safe and naturalistic environments; (2) proper diet; (3) adequate veterinary care; (4) appropriate social contact and (5) environmental enrichment [10, 11]. Overall assessment AW is by no means straightforward and should be carried out in a scientific and objective way, avoiding anthropomorphism and taking no account of ethical topics about the practices or conditions being compared in its evaluation [12, 13].

2. Wildlife veterinarians and conservation medicine

In the past, the primary role of wildlife veterinarians was the intervention and management of free-ranging populations experiencing a health crisis [14]. Epidemic wildlife disease was mainly addressed due to its zoonotic menace (e.g., rabies, brucellosis and tuberculosis) and its harmful outcome in the health of domestic animals or game species considered economically relevant [14, 15]. In the meantime, veterinarians from zoological institutions focused on the *ex-situ* individual, providing healthcare and ensuring compliance of welfare criteria for captive collections while their main part in wildlife conservation projects was considered to be the chemical immobilization of animals in order to enable research [4, 15]. Presently, differences in the role of wildlife and zoo veterinarians are fading as a result of the expansion of the role of the latest in conservation efforts. Such tendency was inevitable due to marked changes in zoo's missionary priorities and an increase in the movement of animals between facilities or for intended release in the wild [2, 3]. When it comes to decide whether to prioritize the interests or rights of animals individually or to focus on the global viability and health of populations and species in specific situations zoological veterinarians are those in the best position to offer a balanced view concerning what the best is for the animals, either from an individual or population perspective. They are expected to actively promote and safeguard animal welfare on the grounds of scientifically justified practices which encompasses a wide range of medical activities, summarized in **Table 1** [16].

2.1 Zoological institutions' evolution and current missions

Zoological institutions have served many different purposes and undergone a remarkable evolution throughout the years until the present days. The first

• Health assessment, surveillance and long-term monitoring for feral and domestic animal populations within park borders • Identification of critical health factors with impact on wildlife population dynamics • Development and enforcement of new health care technologies and methodologies • Provision of preventive, diagnostic and therapeutic health care for wildlife species • Improvement of safety and efficiency of methods of animal handling and secure addressing of other ethical and welfare concerns • Active participation and inspection of zoological management decisions such as husbandry, nutrition, animal shipment and pest control • Scientific biological data collection, analysis and management • Active participation in captive breeding programs • In situ and ex-situ reproductive and health management of threatened species • Disease risk analysis and creation of health screening and quarantine protocols for wildlife translocation projects • Management of emerging disease and health crisis intervention • Research on zoonotic, anthroponotic and interspecies transmission of disease • Interdisciplinary collaboration in conservative efforts • Guidelines and policy development at local, national and international levels • Training of field personnel to expand their skills in addressing wildlife health issues

Table 1.
Applied veterinary medicine and research in supporting both ex-situ and in-situ conservation programs.

models of modern zoos emerged during 18th century, a period known as “Age of Enlightenment” and characterized by educational and scientific endeavors such as animal behavior and anatomy research, which brought a new perspective and goal to the outdated “Menageries” [17]. In the 1970s public opinion began to change and society become more sensitive to the ethical concepts of environmental and animal welfare, leading to the emergence of movements which drove zoos to develop new intentional statements. Such intentions would emphasize the conservation of endangered species, animal welfare and more naturalistic exhibits’ construction, turning the entertainment of visitors into a secondary objective [18].

In this day and age, modern zoos have a far more important role and are beyond the old tight and empty iron barred cages with concrete floors. Despite the fact that they are still profitable and recreational centers, they are now driven by a new set of missions and ethical principles: education and public awareness, scientific research, and reproduction/conservation of endangered species along with the preservation of their habitats [19, 20]. In order to overcome a still widespread infamous reputation which infers that zoos are prisons, holding captive animals for the amusement of humans in conditions which are fully inadequate to ensure their quality of life [21], it is imperative that these missions establish an ethical commitment to one another, so they can ensure the well- being of the animals intended to protect.

Currently, there are a number of institutions which follow a professional code of ethics and are responsible for accrediting modern zoos as well as promoting program coordination and cooperation between zoological gardens and aquariums worldwide. They provide its members with services that meet the highest standards and best practices in animal care, and support scientific research, conservation, and public engagement [22]. The World Association of Zoos and Aquariums (WAZA), for example, is the unifying organization of the zoological community (including more than 300 members) and the founding member of IUCN [23]. All member

institutions have established Taxon Advisory Groups (TAG) for all the different species of animals that are kept in zoos and aquariums. Each TAG focuses on the sustainability and conservation needs of an entire taxa and develops a Regional Collection Plan accordingly, which identifies essential conservative and research goals, develops an action plan and liberates specific recommendations for ex situ and in situ population management [23]. TAG's are composed by professional specialists who are also responsible for advising, managing and supporting cooperative animal management programs like Species Survival Plans (SSP), European Endangered species Programs (EEP) and international Studbooks (SB) [11, 22]. Most endangered species are part of cooperative international and scientifically managed breeding programs whose final goal is to sustain populations that are healthy, genetically viable, demographically stable and capable of self-reproduction, so they can serve as a "gene pool" and surplus for eventual reintroduction in their natural habitat [24, 25].

Accredited zoological institutions ought to have veterinary clinicians working closely with a variety of other institution's organizational staff (such as animal care providers; endocrinology, behavioral or nutritional field specialists; ecologists; regulatory board of directors; and even educational, marketing or facility design departments) and who actively participate in management decisions [2, 15]. Clear communication among the different interest groups existing within a zoological institution allows for the creation of holistic medical programs whose lead foundation is preventive medicine and through which animals can be regarded as one population/community, while still having their individual needs attended [26]. Keeper staff should be trained for clinical health assessment, so they could be better qualified at understanding, identifying and promptly reporting any signs of injury or abnormal behavior that could indicate early disease stages [2]. All data collected and medical records should be condensed in databases like Medical Animal Record Keeping System (MedARKS) or Zoological Information Management System (ZIMS), for cooperative consultancy of disease occurrence and share of information between institutions at a global level. A standardized, computerized medical record-keeping system is a useful tool for management of health care and husbandry practices. By documenting and analyzing medical information that is easily assessed (e.g., clinical notes, treatments, anesthesia, parasitology) it can help future disease assessment or comparison with other populations [27]. Complete reports of necropsies on collection animals should be kept as well, once they can provide information about species anatomy that has great value for surgical procedures.

One of the most exalted contributions of the zoological veterinarian nowadays is its aid in successful captive breeding programs. Apart from securing animal general health, the veterinarian is able to access reproductive health and behavior, monitor breeding cycles, establish management protocols, help in implementing artificial reproductive techniques and effectively control selective reproduction, with resource to permanent or reversible contraceptive methods [2, 3, 14, 15]. Despite the practical and financial difficulties inherent to breeding programs [28], the extremely small capacity of zoos and the relatively uncommon and unsuccessful levels of reintroduction of propagated species, one must not depreciate the importance of zoo's conservative efforts and its ability to reproduce key species which have no other preservation options [5]. In recent years, zoos have bred about 19% of all known mammals' species and at least 9% of the birds [28]. International Studbooks are documents where all records and data relevant to the whole captive population of a certain species integrated in a breeding program, are compiled and continuously updated [23]. They will provide vital information on pedigree and breeding history of individual animals along with several changes in captive populations, and they will assist with references on pairing choices in order to ensure the

maximal genetic diversity within the population. These references will recommend which individuals should breed with whom, how often and where [23, 29, 30]. Studbooks also recommend breeding restrictions in order to avoid future uncontrolled population expansion and therefore achieve stability [24, 30].

3. Veterinarians' role in animal welfare and behavioral assessment

The veterinary works under an ethical code of professional conduct which implies a commitment with integrated principles of animal welfare and the individual responsibility of ensuring a rational enforcement of the “Five Freedoms” (Table 2). All animals must be treated with respect, dignity and compassion as well as with thoughtful consideration for their species-typical biology and behavior [31]. Despite significant advances concerning the animal welfare (AW) topic through recent years, the majority of the research conducted has involved farm and domesticated animals [32, 33]. Zoological collections still include many poorly understood species as well as individuals with different life experiences and particular temperaments [32]. Animal welfare is a wide multi-disciplinary concept for which many definitions have been proposed. Animal welfare as a scientific field started with the Brambell Report on the welfare of intensively farmed animals, issued by the British government in 1965 [34] and later revised by the Farm Animal Welfare Council (FAWC) in 1979, having resulted in the decree of five formalized and rightful freedoms that would form a logical and comprehensive framework for analysis of animal welfare [35]. Farm Animal Welfare Council claims that the welfare of an animal includes both its physical fitness and mental state and that “any animal kept by man, must at least, be protected from unnecessary suffering”. Webster [36] considers that although the “absolute attainment of all five freedoms is unrealistic”, they still represent an “attempt to make the best of a complex and difficult situation”. Some of these freedoms, like the freedom from fear and distress or freedom from pain, are anthropocentric constructs. Fear and pain are normal and essential in appropriate situations, where they work as natural defense mechanisms and may have adaptive and fitness value [37]. Conclusively, the freedoms define “ideal states rather than standards for acceptable welfare” [35] and are best viewed as useful and practical principles that provide the basic philosophy to minimize suffering and promote a state of good welfare and assessment of any husbandry system.

Today, AW can be scientifically assessed to determine the quality of life of individuals, and it implies the integration of the animal's biological function, as well as the subjective emotions and sensations it experiences as a result of the surrounding environment [10]. Consequently, the individual's health is highlighted as a “state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” [38]. Broom [39] also utters that “The welfare of an individual is

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1. **Freedom from hunger and thirst**—by ready access to fresh water and a diet to maintain full health and vigor
 2. **Freedom from discomfort**—by providing an appropriate environment including shelter and a comfortable resting area
 3. **Freedom from pain, injury or disease**—by prevention or rapid diagnosis and treatment
 4. **Freedom to express normal behavior**—by providing sufficient space, proper facilities and company of the animal's own kind
 5. **Freedom from fear and distress**—by ensuring conditions and treatment which avoid mental suffering
-

Table 2.
The “Five Freedoms” which constitute the primary basic principles for animal welfare.

its state as regards its attempts to cope with its environment". Welfare is, therefore, a characteristic of an individual [8, 12] and will vary on a dimensional continuum from very poor to very good [10, 37] as a measure of the animal's perception of its external circumstances and lived experiences [40]. The ability of an organism to tolerate and respond to a range of stimulation, including noxious stimuli, in order to maintain mental and body stability, is called "Coping" [32]. Coping implies the concepts of homeostasis and adaptation, as well as brain activity, endocrine, immunological, physiological and behavioral complex response mechanisms [8]. Scientific consideration of subjective emotional states in AW has been disregarded since these are difficult to identify and quantify [32, 37]. However, active promotion of positive feelings, such as pleasure and contentment, plays a primary role in assuring good welfare status [8, 41] provided that this is determined from an overall balance of experiences. Addressing only the negative emotions and states will not necessarily give rise to positive ones but will merely serve to achieve a neutral situation [10, 40]. Animals have a wide range of needs, which must be always met appropriately according to each species and based on scientific principles, so as to minimize negative welfare states while promoting positive ones [10]. Failure or difficulty to cope with the environment occurs together with the presence of negative emotional states (suffering) and subjective experiences, and it represents a state of poor welfare, from a holistic view of well-being [12, 42]. Animals seek to control interactions with their environment and avoid unpleasant stimuli. When unable to do so, and simultaneously denied resources they are very strongly motivated to obtain, they will achieve a distressful state of frustration and anxiety [10, 43]. Stress is currently defined by its consequences and described as detrimental as a reaction to a challenging stimuli that will activate the organism's hypothalamus-pituitary-adrenal (HPA) axis and produce a response with adverse effects that disrupts homeostasis [8], resulting in overall reduced fitness [32]. It can lead to a variety of short and long term responses characterized by a range of physiological abnormalities (i.e., alterations in hormonal profiles, metabolic changes and cardiovascular malfunction) [8] as well as psychological disorders (maladaptive demeanor such as increased occurrence of pacing, aggression, self-mutilation or fear behaviors) [43]. It is therefore essential to provide animals with productive environments that reward them with fresh challenges, opportunities and choices over time which allow them to express innate behavior and control interactions with their surroundings [8, 10]. Animals are now acknowledged as "sentient beings" [44], considered to have value of their own and to be able of conscious feeling and subjectively perceiving both positive and negative emotions and experiences. Despite the whole concept of AW involving moral values and judgments about our obligations to the animals under our care, it is only after scientific evidence on welfare assessment has been obtained that ethical questions and decisions are ought to be taken [8, 12]. Qualitative and quantitative scientific methods for determining acceptable high standards of AW are complex and multidisciplinary [32] and involve indirect (by taking into consideration the animal needs) and direct measurement of variables, both conducted through observation and experimentation. It is imperative that a variety of "welfare indicators" are used [12] in order to obtain a comprehensive view of the animal's biological state which is characterized by several interacting components that result in neural, endocrine, sensory, immunological and behavioral responses when faced with challenge [8]. WAZA recommends that zoos and aquariums apply a simple "Five Domains" model to facilitate the assessment and understanding of AW, which schematically outlines four functional domains (i.e., "nutrition", "environment", "physical health" and "behavior") and one "Mental" domain. This useful model links a variety of internal/external conditions with the negative (aversive) or

positive (pleasant) experiences they give rise to, and integrates its effects in order to draw the sketch of a welfare status [10]. Some physiological indices cannot be obtained safely in non-trained zoo animals without the use of anesthesia or sedatives (e.g., changes in heart and respiratory rates, blood parameters, hormonal profiles or neurotransmitters' levels) [8]. Alternatively, other internal parameters can be collected noninvasively, for example, measuring reproductive or stress hormones and their metabolites in urine or feces (e.g., fecal estrogens or fecal glucocorticoids) [12, 32]. The HPA axis' frequent and high activity is the most often used physiologic measure [32], very useful in assessing stress responses and impaired immune system associated with environmental disturbance. It is usually monitored noninvasively through analysis of fecal cortisol/corticosterone [42, 45]. Although efforts should be made to include the importance of both positive (pleasure, contentment) and negative feelings or sensations (suffering, fear, pain) in the assessment of AW, these imply complex brain constructs and functioning mechanisms which are not easy to evaluate in a fully objective way [8]. Dawkins [43] argues that animal welfare should be assessed by answering two essential questions: (1) Are the animals healthy? and (2) Do they have what they want?, and that these two queries concentrate both the physical and the mental features of AW. Some indirect methods that help answering these key questions and are frequently used for AW assessment and improvement, include behavioral observation associated with tests that identify individuals' choices/preferences or study their motivational strength by "asking" the animals what they want and how much they want it. The way an animal responds to given opportunities in its environment offers valuable information about its emotional state and motivation, and helps to determine a particular hierarchy of needs [40, 45].

Animal welfare is considered to be a scientific branch of applied animal behavior and may be measured through behavioral assessment [46]. Understanding behavioral diversity, its function and its relation with the animal's perception of their external circumstances is important as it might help to prevent what is considered an abnormal demeanor or to improve conditions that are appropriate for normal repertoires. Skinner [47] considers that behavior is "part of the total activity of an organism" and that "is that part of the functioning organism which is engaged in acting upon or having commerce with the outside world". Behavior as a specific response, therefore represents the first line of defense to environmental challenging stimuli and may delineate a rough sketch of an animal's coping success against external stressors [10, 42]. It plays a major role in answering Dawkins' [43] questions: (1) "Are the animals healthy?" and (2) "Do they have what they want?", since it encompasses animals' own decision-making process and represents a phenotypic expression of emotions [43] while it also may be used in the clinical assessment of animal's health status (e.g., assessment of pain, nutritional requirements and hormonal conditions) [43, 48]. Behavior assessment through applied behavior analysis and behavioral monitoring studies is a technique that has several benefits supporting optimal animal care, making it essential to improve animal welfare and to meet conservation goals. These studies have emphasis on scientific data collection through direct and objective observation of measurable behavior as well as the circumstances under which they occur, and concern the functional relationships between environment and expressions of behavior [43, 48]. Systematic observations and record keeping have numerous advantages as a management tool in zoos and other related facilities: they represent a non-invasive and, in the majority of cases, a non-intrusive technique [43] that allows documentation of normal behavior patterns and identification of any changes on regular activity, establishing a database of background information on individuals on a consistent basis [48].

3.1 Behavioral enrichment

The History of enrichment starts in the 1920s with Robert Mearns Yerkes [49], a psychobiologist best known for his work in intelligence testing of both humans and primates and his writings about the importance of enrichment for gorillas and chimpanzees in captivity [50]. The Swiss zoologist Heini Hediger (1908–1992), known as the “father of zoo biology”, was a visionary in the proxemics in animal behavior. In the 1950s, and for the next several decades, he wrote about human responsibility in providing constructive environments for wild animals in zoos and described the importance of studying animal’s territorial surroundings, having a particular influence on the construction and planning of naturalistic enclosures [49, 51]. His revolutionary concepts are well expressed in his book in which he refers that “Anyone who sets out to build homes for animals should be quite clear that the cube is the most unbiological and therefore most inappropriate of all spatial forms” [52].

The American psychologist and behaviorist Skinner had strong implications on enrichment as well. He used operant conditioning to strengthen behavior, created the principles of reinforcement and introduced the process of shaping, techniques that are still used today in many animal training husbandry and medical procedures, and represent a gold standard for dealing with behavioral problems in a variety of settings [50]. He also reported sterile environments causing animals to engage in repetitive behaviors [49]. Hal Markowitz also made significant contributions to the expansion of social consideration about enrichment since the 1970s, being a pioneer in marine mammal research and extending the work by former authors concerning operant conditioning in order to apply this science to improve animal’s life [49]. There have been tremendous improvements regarding animal care and captive settings throughout recent years. Replication of wild conditions and stimulation of wild biological repertoires in captive animals have been a long term conservational goal for many zoological institutions. This way, behavioral enrichment programs have become an accepted practice whose most generic priority is addressing and reducing undesirable behaviors [53, 54].

Behavioral enrichment, also known as environmental enrichment, is currently a principle of animal husbandry that has been scientifically proofed to be beneficial [10, 19]. It should be fully incorporated in the daily routine of animals as a tool to maximize their quality of life and discourage undesirable behaviors that emerge as “artifacts of captivity” (e.g., stereotypies) [9, 19]. Enrichment is officially defined as “a dynamic process for enhancing animal environments within the context of the animals’ behavioral biology and natural history. Environmental changes are made with the goal of increasing the animals’ behavioral choices and drawing out their species-appropriate behaviors, thus enhancing animal welfare” [55]. The aims of behavioral enrichment can be achieved by creating productive environments which encourage each animal to express the natural mental activities and behavioral repertoire of the species, and by adding stimulus that offer complexity and novelty to its routine as well as opportunities that enable it to restore the sense of control it should have over its environment [55]. Behavioral programs have a role in fighting against inactivity and obesity, reducing/eliminating stereotyped and aberrant behavior (e.g., aggression, sexual frustration), and decreasing levels of stress which can, alone, indulge reproduction [9, 55]. For an enrichment program to succeed, it is very important that it is methodically planned in accordance with its objectives and desired outcomes, otherwise it may be more harmful than beneficial [19]. The foundation and logistics of a successful, goal-orientated and self-sustained program can be outlined through AZA reviewed guidelines and protocols so as to represent a master plan from goal setting to re-adjustment, addressing safety issues, providing and keeping up-to-date resources [55]. All animal care staff members and all the professional sectors in the

zoological institutions must be involved in the development of an animal enrichment program, as each one plays a critical role in its success [19, 56]. Disney's Animal Kingdom developed the 'S.P.I.D.E.R' framework, a solid model which works as a valuable tool in the development, implementation and maintenance of institutional training and enrichment programs. These programs provide species with appropriate challenges, opportunities and stimulation for all taxa [10, 56]. S.P.I.D.E.R is an acronym for the first letter of each component of the framework [57], as follows: setting goals; planning; implementation; documenting; evaluation; re-adjustment. The last component of the framework actually takes place during all the process of development of an enrichment plan [56]. The goals of a plan are regularly re-adjusted and enrichment activities refined, improved or discontinued to increase effectiveness of a strategy, which may, at some point, be started over again [55]. Five, not mutually exclusive, enrichment categories are generally recognized which will cover the basic needs of an animal and increase a positive utilization of its environment: (1) sensory; (2) structural/physical; (3) social (4) cognitive and (5) food/nutrition [55].

Sensory enrichment refers to the five perceptual senses of sight, smell, hearing, taste and touch [19]. Olfactory stimulation is of the main importance in behavioral enrichment as many species use olfactory signalment to communicate with intra and inter specific as well as to maintain their territories. They are also driven by their sense of smell to locate prey, reproductive mates or food [54, 58]. Olfactory enrichment may include addition of scented material and both packaged and natural odors [33, 59, 60]. On the other hand, daily removal of natural odors from enclosures through husbandry routine practices should be avoided as it leads to clearance of important olfactory cues in the animal's environment [13]. The value of auditory stimulation to the well-being of animals is still controversial in the literature. It can be vaguely divided into sounds specific of a specie's natural habitat and sounds that are not found in the wild [44]. It is important to bear in mind that the addition of extra noise to environments which can be pretty loud themselves may also have a negative impact in their dwellers, including hearing impairment and communication disconcert between animals [9, 13]. In some cases, the most significant aspect regarding acoustic stimulation so far, may be the overall reduction of the ambient noise [13]. Visual means of enriching the captive environment of animals may include addition of mirrors, moving toys, televisions or other computer-assisted equipment as well as simply allowing the sight of activities outside the enclosure or of a prey [13, 19]. The tactile category includes a varied set of toys, subtracts and other artificial/natural manipulanda, which can be provided in different shapes and textures, either permanently or through a rotation scheme in order to maintain interest, and in close association with the other classes of sensorial enrichment [9, 61].

"Foraging", as a concept that comprises searching, retrieving, acquiring and processing food [61], is a time consuming activity that constitutes a major portion of the daily time budget of animals in the wild [19, 62]. Captivity, on the other hand, provides animals with a more limited selection of food types, usually processed diets that are dispensed in highly predicted locations, at fixed feeding times, and in an easily consumed form which does not require natural foraging tactics [9, 62]. Feeding animals through more versatile and natural ways is one of the most widely used enrichment techniques [63].

Structural enrichment highlights the utmost importance of the quality of the space available in overcoming space restrictions [9, 52]. A revolution in zoo enclosure design has led to a proliferation of more naturalistic exhibits which replicate as closely as possible the wild habitat of the species concerned [23, 52]. These exhibits are also functionally evaluated with the priority of creating stimulating and appropriate captive environments according to the specific behaviors and biological needs of each species [55].

Social enrichment involves all forms of social interactions provided direct or indirectly by conspecifics, humans and other species of animals, through physical contact, verbal communication or even olfactory signalment [56]. Many studies instigate the importance of housing appropriate social groupings in the welfare of captive animals [64, 65]. The term “mixed-species exhibits” implies inter-specific associations of animals that would naturally occur in the wild [19].

Cognitive/mental stimulation may be carried out through provision of training sessions, puzzle feeders and other cognitive devices that require animals to solve a problem [19, 55]. Training, based on both classical and operant conditioning principles is a revolutionary way of intellectually challenging the everyday routine of captive animals while managing them to comply with basic husbandry tasks or medical procedures without being forced to do so [61].

Enrichment in its most varied forms elicits investigatory, foraging or marking behavior, social interaction, and creative play. It also provides shade and privacy through hiding places or escape routes, leading to a more efficient use of space [9, 61]. However, the results of every approach will depend on intrinsic factors such as species, age, sex and individual personality [13]. The animal’s environment can thus be manipulated and modified in countless ways through a holistic view of the animal’s biology, being the limit our own creativity. However, enrichment will not only be beneficial for the animals but for the general public as well. Through promotion of natural species-specific behaviors, enrichment will create valuable and more accurate educational opportunities for the visitors to learn about animal’s natural history, biology and conservation. Consequently, it will enhance guest’s experiences and their perception of the zoological institutions’ mission [19, 55].

4. Conclusion

Veterinarians are irrevocable generalists, which makes them proficient in the holistic approach of disease dynamics. They have not only a broad education in comparative medicine (not a single-species focus) but also in many specialties such as surgery, clinical medicine, anesthesiology, epidemiology, nutrition, pathology, toxicology, theriogenology and behavior. This makes them excellent at understanding both mental and physical needs of an animal, and how well adapted it is to its environment [3, 15]. Wildlife vets are also highly trained in recognizing, diagnosing and understanding disease impact on public health as well as on individuals, populations and whole ecosystems; and, in choosing the most advisable preventive and therapeutic options on a case by case basis [14, 15]. Their ubiquitous knowledge, skills and expertise therefore turns them into valuable key players in planning, implementing and effectively assisting both in-situ and ex-situ conservation projects [2]. As a result, deep collaboration between veterinarians and professionals of other scientific fields such as applied biomedics, epidemiology, ecology, biology and evolutionary genetics, is becoming positively accepted as a new way of integrating health sciences into conservation [2, 15] thus defining Conservation Medicine.

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Author details

Diana Raquel Neves Fernandes¹ and Maria de Lurdes Ribeiro Pinto^{2*}

1 National Center for the Reproduction of the Iberian Lynx (CNRLI), Herdade das Santinhas, Silves, Portugal

2 Animal and Veterinary Research Centre (CECAV), Trás-os-Montes e Alto Douro University, Vila Real, Portugal

*Address all correspondence to: lpinto@utad.pt

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References

- [1] Pimm SL, Jenkins CN, Abell R, Brooks TM, Gittleman JL, Joppa LN, et al. The biodiversity of species and their rates of extinction, distribution, and protection. *Science*. 2014;**344**(6187):1246752. DOI: 10.1126/science.1246752
- [2] Deem SL. Conservation medicine to one health: The role of zoologic veterinarians. In: Fowler M, Miller R, editors. *Fowler's Zoo and Wild Animal Medicine*. 1st ed. Vol. 8. Missouri: Elsevier; 2015. pp. 698-703
- [3] Jakob-Hoff R, Warren KS. Conservation medicine for zoo animals. In: Fowler M, Miller R, editors. *Fowler's Zoo and Wild Animal Medicine*. Vol. 7. Missouri: Elsevier; 2012. pp. 15-23
- [4] Karesh W, Cook R. Applications of veterinary medicine to in situ conservation efforts. *Oryx*. 1995;**29**(4):244-252. DOI: 10.1017/S0030605300021232
- [5] Conway W. Wild and zoo animal interactive management and habitat conservation. *Biodiversity and Conservation*. 1995;**4**:573-594. DOI: 10.1007/BF00222515
- [6] Whilde J, Martindale MQ, Duffy DJ. Precision wildlife medicine: Applications of the human-centred precision medicine revolution to species conservation. *Global Change Biology*. 2017;**23**:1792-1805. DOI: 10.1111/gcb.13548
- [7] McPhee ME, Carlstead K. Effects of captivity on the behavior of wild mammals. In: Kleiman DG, Allen M, Thompson K, editors. *Wild Mammals in Captivity*. 2nd ed. Chicago: University of Chicago Press; 2010. pp. 303-313
- [8] Broom DM. Coping, stress and welfare. In: Broom DM, editor. *Proceedings of Dahlem Conference on Coping with Challenge: Welfare in Animals Including Humans*. Berlin: Dahlem University Press; 2001. pp. 1-9
- [9] Newberry RC. Environmental enrichment: Increasing the biological relevance of captive environments. *Applied Animal Behaviour Science*. 1995;**44**:229-243. DOI: 10.1016/0168-1591(95)00616-Z
- [10] Mellor DJ, Hunt S, Gusset M, editors. *Caring for Wildlife: The World Zoo and Aquarium Animal Welfare Strategy*. Gland: WAZA Executive Office; 2015. 87 p
- [11] European Association of Zoos and Aquaria (EAZA). Available from: <http://www.eaza.net/> [Accessed: Oct 5, 2018]
- [12] Broom DM. Animal welfare: Concepts and measurement. *Journal of Animal Science*. 1991;**69**:4167-4175. DOI: 10.2527/1991.69104167x
- [13] Wharton D, Mainka SA. Review: Snow leopard management and husbandry. *International Zoo Yearbook*. 1997;**35**:139-147. DOI: 10.1111/j.1748-1090.1997.tb01203.x
- [14] Deem SL, Karesh WB, Weisman W. Putting theory into practice: Wildlife health in conservation. *Conservation Biology*. 2001;**15**:1224-1233
- [15] Deem SL. Role of the zoo veterinarian in the conservation of captive and free-ranging wildlife. *International Zoo Yearbook*. 2007;**41**:3-11. DOI: 10.1111/j.1748-1090.2007.00020.x
- [16] Minteer BA, Collins JP. Ecological ethics in captivity: Balancing values and responsibilities in zoo and aquarium research under rapid global change. *ILAR Journal*. 2013;**54**:41-51. DOI: 10.1093/ilar/ilt009

- [17] National Geographic [Internet]. 2008. Available from: <https://www.nationalgeographic.org/encyclopedia/zoo/> [Accessed: Sep 10, 2018]
- [18] Rothfels N. *Savages and Beasts: The Birth of the Modern Zoo*. Baltimore: Johns Hopkins University Press; 2008. 288 p
- [19] Cipreste CF, de Azevedo CS, Young RJ. How to develop a zoo-based environmental enrichment program: Incorporating environmental enrichment into exhibits. In: Kleinman DG, Thompson KV, Baer CK, editors. *Wild Mammals in Captivity: Principles and Techniques for Zoo Management*. 2nd ed. Chicago: The University of Chicago Press; 2010. pp. 171-180
- [20] Moss A, Esson M. The educational claims of zoos: Where do we go from here? *Zoo Biology*. 2013;**32**:13-18. DOI: 10.1002/zoo.2102
- [21] People for the Ethical Treatment of Animals (PETA) [Internet]. 2008. Available from: <https://www.peta.org/issues/animals-in-entertainment/zoos-pseudo-sanctuaries/> [Accessed: Sep 20, 2018]
- [22] Associations of Zoos and Aquariums [Internet]. 2018. Available from: <https://www.aza.org/code-of-ethics> [Accessed: Nov 2, 2018]
- [23] World Association of Zoos and Aquariums: WAZA [Internet]. 2018. Available from: <http://www.waza.org/en/site/home> [Accessed: Oct 6, 2018]
- [24] Rai S. *National Studbook of Snow leopard (Panthera uncia)*. New Delhi: Wildlife Institute of India, Dehradun and Central Zoo Authority; 2015. pp. 20-27
- [25] World Health Organization: WHO [Internet]. 2018. Available from: <http://www.who.int/about/mission/en/> [Accessed: Oct 5, 2018]
- [26] Kreger MD, Hutchins M. Ethics of keeping mammals in zoos and aquariums. In: Kleinman DG, Thompson KV, Baer CK, editors. *Wild Mammals in Captivity: Principles and Techniques for Zoo Management*. 2nd ed. Chicago: The University of Chicago Press; 2010. pp. 3-10
- [27] Mikota SK, Aguilar RF. Management protocols for animal in captive propagation and reintroduction programmes. *Revue Scientifique et Technique (International Office of Epizootics)*. 1996;**15**:191-208
- [28] Conway W. The practical difficulties and financial implications of endangered species breeding programmes. *International Zoo Yearbook*. 1986;**24/25**:210-219
- [29] Bloomqvist L. The captive snow leopard in 2007. In: *International Pedigree Book for Snow Leopards, Uncia uncia*. Helsinki: Helsinki Zoo; 2008. 175 p
- [30] Jackson RM, Mishra C, McCarthy TM, Ale SB. Snow leopards: Conflict and conservation. In: Macdonald DW, Andrew J, editors. *The Biology and Conservation of Wild Felids*. Oxford: Oxford University Press; 2010. pp. 417-430
- [31] Kagan R, Veasey J. Challenges of zoo animal welfare. In: Kleinman DG, Thompson KV, Baer CK, editors. *Wild Mammals in Captivity: Principles and Techniques for Zoo Management*. 2nd ed. Chicago: The University of Chicago Press; 2010. pp. 11-21
- [32] Hosey GR, Melfi VA, Pankhurst SJP. *Zoo Animals: Behaviour, Management and Welfare*. Vol. 643. Oxford: Oxford University Press; 2009
- [33] McGlone JJ, Anderson DL. Synthetic maternal pheromone stimulates feeding behaviour and weight gain in pigs. *Journal of Animal Science*. 2008;**80**:3179-3183

- [34] Brambell Report. Report of the Technical Committee to Enquire Into The welfare of Animals Kept under Intensive Livestock Husbandry Systems [Internet]. London, UK: Her Majesty's Stationery Office. 1965. Available from: <http://edepot.wur.nl/134379> [Accessed: Nov 3, 2018]
- [35] The National Archives [Internet]. 2018. Available from: <http://webarchive.nationalarchives.gov.uk/20121003015231/http://www.defra.gov.uk/fawc/about/five-freedoms/> [Accessed: Nov 2, 2018]
- [36] Webster J. Animal Welfare: A Cool Eye Towards Eden. Wiley; 1995. 284 p
- [37] Kolter L, Zander R. Potential and limitations of environmental enrichment in managing behavioural problems of polar bears. In: Proceedings of the Second International Conference on Environmental Enrichment; 21-25 August 1995; Copenhagen: Copenhagen Zoo; 1995. p.131-141
- [38] World Organization for Animal Health (OIE). Terrestrial Animal Health Code. 20th ed. Paris: World Organisation for Animal Health (OIE); 2011. pp. 289-382
- [39] Broom DM. Indicators of poor welfare. *British Veterinary Journal*. 1986;**142**:524-526
- [40] Melfi VA. There are big gaps in our knowledge, and thus approach, to zoo animal welfare: A case for evidence-based zoo animal management. *Zoo Biology*. 2009;**28**:574-588. DOI: 10.1002/zoo.20288
- [41] Boissy A, Manteuffel G, Jensen MB, Moe RO, Spruijt B, Keeling LJ, et al. Assessment of positive emotions in animals to improve their welfare. *Physiology & Behavior*. 2007;**92**:375-397. DOI: 10.1016/j.physbeh.2007.02.003
- [42] Webster AJF. Farm animal welfare: The five freedoms and the free market. *The Veterinary Journal*. 2001;**161**:229-237. DOI: 10.1053/tvjl.2000.0563
- [43] Dawkins MS. Using behaviour to assess animal welfare. *Animal Welfare*. 2004;**13**:S3-S7
- [44] European Commission [Internet]. 2018. Available from: https://ec.europa.eu/food/animals/welfare_en [Accessed: Sep 27, 2018]
- [45] Broom DM. The scientific assessment of animal welfare. *Applied Animal Behaviour Science*. 1988;**20**:5-19
- [46] Rees PA. Studying Captive Animals: A Workbook of Methods in Behaviour, Welfare and Ecology. Oxford: Wiley; 2015. 318 p
- [47] Skinner BF. The Behavior of Organisms. Cambridge: Copley Publishing Groups; 1938. 473 p
- [48] Bishop J, Hosey G, Plowman A, editors. Handbook of Zoo Research, Guidelines for Conducting Research in Zoos. London: BIAZA; 2013. pp. 63-71
- [49] Cambridge Center for Behavioral Studies [Internet]. 2018. Available from: <https://behavior.org/help-centers/animal-behavior/enrichment/>
- [50] B.F. Skinner Foundation [Internet]. 2018. Available from: <http://www.bfskinner.org/> [Accessed: Oct 10, 2018]
- [51] Maple TL. Prof. Dr. Heini Hediger (1908-1992). *Zoo Biology*. 1992;**11**:369-372
- [52] Hediger H. Man and Animal in the Zoo: Zoo Biology. New York: Delacorte Press; 1969. 303 p
- [53] Mason GJ, Latham NR. Can't stop, won't stop: Is stereotypy a reliable animal welfare indicator? *Animal Welfare*. 2004;**13**:S57-S69
- [54] Skibieli AL, Trevino HS, Naugher K. Comparison of several types of enrichment for captive felids. *Zoo Biology*. 2007;**26**:371-381. DOI: 10.1002/zoo.20147

- [55] Young RJ. Environmental enrichment for captive animals. Oxford: Blackwell Science. 2003. 228 p
- wild mammals in zoos. *Applied Animal Behaviour Science*. 2007;**10**:255-264.
DOI: 10.1016/j.applanim.2006.05.021
- [56] Animal Enrichment [Internet]. 2018. Available from: <http://www.animalenrichment.org/spider>
- [57] Sevenich MM, Mellen J. Animal Training: [Internet]. 2018. Available from: <http://www.animaltraining.org/spider/> [Accessed: Oct 13, 2018]
- [58] Hurst JL, Beynon RJ, Roberts SC, Wyatt TD. Chemical Signals in Vertebrates. New York: Springer; 2008. 417 p
- [59] Estelles MG, Mills DS. Signs of travel-related problems in dogs and their response to treatment with dog-appeasing pheromone. *Veterinary Record*. 2006;**59**(5): 143-148
- [60] Graham L, Wells DL, Hepper PG. The influence of olfactory stimulation on the behaviour of dogs housed in a rescue shelter. *Applied Animal Behaviour Science*. 2005;**91**:143-153
- [61] Tresz H. Contra freeloading (working for food) at the Phoenix zoo. *ABMA Wellspring*. 2010;**11**:8-21
- [62] Newberry RC. The space-time continuum, and its relevance for farm animals. *Etologia*. 1993;**3**:219-234
- [63] Young RJ. The importance of food presentation for animal welfare and conservation. *Proceedings of the Nutrition Society*. 1997;**56**:1095-1104
- [64] Shepherdson DJ. Environmental enrichment: Past, present and future. *International Zoo Yearbook*. 2003;**38**:118-124
- [65] Price EE, Stoinski TS. Group size: Determinants in the wild and implications for the captive housing of