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Introduction
Zoos and aquariums have traditionally depended on external consultant veterinarians to maintain and improve the health and welfare of animal collections, mainly wild-caught and from the tropics. Contracted veterinary care in the 19\textsuperscript{th} and 20\textsuperscript{th} century was typically through diagnosis and treatment of diseases, parasites and other conditions\textsuperscript{1,2}. This was usually done in the enclosure with none, or only rudimentary laboratory and quarantine facilities in support; and working closely with keeping staff and “stockmen-managers” who, at that time, had a limited professional training. Work focused on individual exotic animals, mainly higher vertebrates, cared for outside of their natural environment (\textit{ex situ}) sometimes in bare concrete or tiled cages which were supposedly more hygienic. These animals were sometimes held at excessively high stocking densities and in artificial, biologically inappropriate circumstances designed for ease of public viewing and management access rather than to meet welfare needs. In the process of care and treatment, comparatively little consideration was given to the ecology of animals in the wild, life histories, reproductive biology or natural diets\textsuperscript{3}; and, in many cases basic anatomical and physiological and genetic information was absent, including systematic written records. The conservation status of the animals was hardly a consideration, other than their ‘rarity value’ and cost of acquisition. Mortality rates were sometimes high from a widespread ignorance of basic husbandry needs across diverse taxa; and a lack of experience in treating obscure endemic diseases or parasites not hitherto encountered or recognised. Often, there was a lack of professional organisation, training and communication.

Organisational development
While some small shadows of the past may remain, much has changed for the better in the late 20\textsuperscript{th} and early 21\textsuperscript{st} century. There is an international trend for zoos to establish dedicated hospital and quarantine facilities and engage a professionally trained, multi-skilled, in-house animal care team. This may in various (albeit sometimes part-time) combinations, comprise of veterinary surgeons, nurses, curators, keepers, nutritionists, endocrinologists, geneticists, cryobiologists, behaviourists, psychologists and zoological registrars who manage complex electronic biomedical records databases. For all such staff there is now a rapidly growing national and international network of specialised, zoo-affiliated organisations such as the American Association of Zoo Veterinarians, the European Association of Zoo and Wildlife Veterinarians, the Association of Reptilian and Amphibian Veterinarians, the Pan-African Sanctuary Alliance for Great Apes, the European Association of Zoo Nutritionists, the Frozen Ark
(Cryobiological) Consortium and the International Congress of Zookeepers. These professional bodies were established to set and continuously improve on standards, to share technical information and through their proceeding to widely disseminate the results of clinical observations and scientific research, including in taxonomically or thematically specialised areas. Major research institutes have developed which include specialisation in zoo and wildlife medicine, e.g. the Institute of Zoology, London; the Center for Research on Conservation, Antwerp Zoo; the National Centre for Zoonosis Research, Liverpool University, and the Leibniz Institute for Zoo and Wildlife Research, Berlin - who host an annual International Conference on Diseases of Zoo and Wild Animals.

**Contemporary progress**

We now see veterinary work being conducted in zoos specifically for conservation purposes⁴⁻⁵, including assisted reproduction where appropriate. This is often accompanied by complimentary veterinary conservation programmes in the wild (*in situ*) including clinical protocols for re-introduction. There are a number of serial publications which publish reviews or synoptic accounts of issues and advances in zoo animal health in relation to conservation⁶. While the number of animal specimens and species held has often been reduced in individual zoos, there is far more overall taxonomic breadth to modern collections - with increased attention given to lower vertebrates and invertebrates, to aquatic taxa⁷ and to species listed as Threatened with Extinction on the IUCN Red List. There is a shift to proactive behavioural and genetic management of small populations, rather than individual post-hoc interventions; and emphasis on preventative medicine, behavioural enrichment⁸ and evidence-based decision making – sometimes involving sophisticated laboratory diagnostics and bio-medical research projects⁹. There is an increased consideration of compliance issues including national and international animal health and welfare regulations, zoo licensing requirements, husbandry standards, enclosure design, acquisitions, disposals, euthanasia, animal transport, CITES regulations and the Balai Directive on international transfer of biomedical samples. Contemporary SHE (safety, health and working environment issues) include: animal escapes, sedative and anaesthetic (drugs and darts) protocols, radiological safety, pathology, use and disposal of biological or post-mortem materials. To the forefront are studies in: bio-banking, cryobiology, zoonoses, epidemic diseases, biosecurity and emergent infectious diseases¹⁰, including in relation to climate change¹¹⁻¹². There is a corresponding increase in ELSE (ethical, legal, social and natural environment) issues, requiring institutional Ethical Review Processes - considering, for example, assisted reproduction, contraception and experimentation. The health and welfare of elephants and the great apes¹³ in zoos and of wild cetaceans in public aquariums is intensely debated, covering both physical and mental aspects. Following the World Zoo and Aquarium Conservation Strategy ⁶ the Global Aquarium Strategy ¹⁴ and the European Zoo and Aquarium Research Strategy¹⁵, there are growing international programmes in zoological veterinary science, organised through NGOs such as WAZA, EAZA, AZA, SEAZA, AZWV, PASA, ISIS and IUCN-CBSG. Many zoos and aquariums now engage in conservation, education and scientific work in the field (*in situ*). This encompasses wildlife medicine and veterinary training, in close collaboration with veterinary faculties in the universities. Re-introduction and field conservation programmes increasingly utilise the skills of veterinarians in partnership with teams in the habitat countries. Today, unusual diseases associated with global climate change are receiving attention, such as bleaching syndrome in coral.
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References