Proceedings of the 19th Sharjah International Conservation Forum for Arabia's Biodiversity

Key Biodiversity Areas

Drones for Conservation

Clinical Diagnostics in Zoo and Wild Animals

Red List Assessment of Endemic Plants

5-8 February 2018

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Clinical Diagnostics in Zoo and Wild Animals

Red List Assessment of Endemic Plants

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Executive Summary

The 19th Annual Sharjah International Conservation Forum for Arabia's Biodiversity (SICFAB) was held at the Breeding Centre for Endangered Arabian Wildlife (BCEAW) in Sharjah, United Arab Emirates (UAE), during 5-8 February, 2018. This Forum brought together over 200 participants from Jordan, Kuwait, Lebanon, Yemen, Bahrain, UAE, Saudi Arabia, Oman, and Iraq, and also from the UK, South Africa, Australia, the USA and New Zealand. The workshops are hosted by the Environment and Protected Areas Authority of the Government of Sharjah, under the patronage of H.H. Sheikh Dr Sultan bin Mohammed al Qasimi, Member of the Supreme Council and Ruler of Sharjah.

The 19th meeting had four themes:

1. The IUCN Red List theme conducted an assessment of the endemic plants of the Arabian region, except for the trees an aloes which were assessed in 2017. In total, 375 species were assessed, 21% of which were assessed as threatened, including 30 Critically Endangered species. This marked completion of the first comprehensive assessment of the status of all endemic plants in the region. The results of this assessment will be published separately and made available from the IUCN website in due course and is not considered in this report.

2. The Key Biodiversity Areas (KBA) theme applied the new IUCN KBA Standard to selected taxa and sites across the Arabian Peninsula: Taxonomic and regional working groups applied the KBA Standard to 37 species of threatened Arabian plants and animals, including 6 species of mammal, 7 bird species, 11 reptiles, one amphibian, and 13 aloes. Delegates identified and then delineated KBA sites on the basis of these taxa. The development of regional criteria for KBAs was also discussed.

3. The technical theme looked at the application of drones in ecological monitoring and conservation management in the UAE: Case studies were presented for the application of both quad-copters and fixed wing drones for vegetation monitoring, counts of shorebirds and of turtles, and monitoring of herd dynamics in Arabian oryx. Delegates discussed the opportunities, constraints, and challenges relating to the expansion of drone-based ecological monitoring in the Arabian Peninsula region.

4. The veterinary theme considered clinical diagnostics and immunology in zoo and wild animals: The main focus was haematology, clinical chemistry, urinalysis, clinical immunology, neonatal immunology, vaccination and diagnostic testing, and the identification of disease using blood smears. Lectures introducing the topics were complimented with small-group sessions where case studies were discussed and diagnoses made. It was agreed that this basic approach to animal health should be developed in the region in order to equip veterinarians better for the pivotal role they must play in ecosystem health.

Key Biodiversity Areas Theme

Key Biodiversity Areas in the Arabian Peninsula: A Preliminary Assessment

David Mallon and Helen Senn

Introduction

Key Biodiversity Areas (KBAs) are sites that make significant contributions to the global persistence of biodiversity. The International Union for the Conservation of Nature (IUCN), in collaboration with other partners, has developed a global Standard for the identification of KBAs (IUCN 2016). The KBA Standard[1] includes formal definitions, site criteria and thresholds, and procedures for delineation. The KBA Standard is designed primarily for use at global level but may also be applied at regionally and nationally.

The KBA Standard consists of five criteria:

1. Threatened biodiversity;
2. Geographically restricted biodiversity;
3. Ecological integrity;
4. Biological processes; and
5. Irreplaceability through quantitative analysis.

These are accompanied by thresholds and specified ways in which global population size or occupied habitat may be observed or inferred. The process of identifying KBAs has two main stages, firstly the application of the criteria and thresholds, followed by the delineation of site boundaries.

One of the main themes of the 2018 SICFAB was to use the global KBA Standard to identify a provisional set of KBAs in the Arabian Peninsula. This was one of the first times that KBA Standard had been applied at such a large scale.

The KBA workshop involved 75 participants including representatives from 8 countries in the region. Dr Penny Langhammer, of Global Wildlife Conservation, who also co-led the task force that developed the IUCN Standard, led the workshop.

Methods

The workshop began with a detailed introduction to the KBA Standard, the criteria and the thresholds (summarised in Table 1). This was followed by a training session in which the participants worked in small groups on a series of exercises drawn from different regions across the world to familiarise them with the application of the criteria.

Lists of globally threatened taxa occurring in the region were compiled in preparation for the workshop. Four parallel taxonomic working-groups (mammals, birds, herpetofauna and plants) then used these lists as a starting point to apply KBA criterion A1 (Threatened species) to identify a first set of sites for the region (Table 2). Relatively few plants have been red-listed in the region to date, so a subset was chosen, taken from the trees and aloes that were assessed at the 2017 Sharjah workshop (Table 2).

[1] IUCN (2016) A Global Standard for the identification of Key Biodiversity Areas Version 1.0. First edition. Gland, Switzerland: IUCN

The first step was to identify, for each species, the thresholds for meeting criteria A1 (Table 1). For example, *Gazella arabica* (VU, population size 10 000) would trigger threshold A1b " ≥1.0% global population and ≥ 10 RU of a VU species" at any site where a population of 100 more individuals was present; *Phoenicolacerta kulzeri* (EN, range 500 km^2) would trigger threshold A1a "≥0.5% global population and ≥5 RU of a CR/EN species" at any site where it was found over 2.5 km^2 or more; whilst *Aloe whitcombei* (EN, <250 found at one location) would trigger A1e "Effectively the entire population of a CR/EN species" (Table 1).

Once the relevant thresholds had been identified, the groups then identified all sites within the region that would trigger the thresholds for each species. For example, for Arabian oryx *Oryx leucoryx* (VU, population size 1 000) all sites that met the A1b criteria (i.e., they contained over 10 reproductive units) were identified: Mahazat As Sayd (KSA), Uruq Bani Ma'arid (KSA), Wadi Rum PA (Jordan), Jaddat AL Harasis (Oman), Arabian Oryx PA (UAE) (

Figure 1). Whilst for the Omani spiny-tailed lizard *Uromastyx thomasi* (VU, global population range 96 302 km^2) the Arabian Oryx PA (UAE) was the only site considered to meet the A1d threshold of presence over an area ≥138.6 km^2.

Figure 1 Arabian oryx in the Arabian Oryx Protected Area at Umm al Zumoul, Abu Dhabi, one of the provisional KBA sites identified.

Photo © D. Mallon

The taxonomic working groups then applied criteria B1, B2 (geographically restricted species and assemblages) to relevant qualifying species, and in the case of birds, also criterion D1 (demographic aggregations) to identify a further set of provisional KBAs.

The workshop did not attempt to apply all the KBA criteria. Criteria A2 and B4, relating to ecosystems, were not used pending agreement on ecosystem categorisation in the region; criterion C on ecological integrity was deemed inapplicable, mainly because the long history of human settlement in the region and level of development, made it unlikely that any parts of the

region would qualify; criterion E was also not applied because there are as yet no quantitative analyses available to assess irreplaceability.

Some of the KBAs qualified for more than one species so the provisional list of sites was then reviewed and sites were aligned, resulting in a list of 56 sites covering 79 separate triggering locations-by-species combinations (triggering events). Within the sub-region of the UAE, Kuwait, Bahrain, North and Central Saudi Arabia there were 18 sites triggered by 27 separate events covering 11 species. Within the sub-region of Yemen, Oman, and southwest Saudi Arabia there were 30 sites triggered by 43 separate events involving 22 species. In the third region covering the Jordan, Lebanon, Iraq and Syria (excluding the Mediterranean ecoregion) there were eight sites triggered by nine separate events involving 7 species (Table 3).

Following consolidation of the sites, the participants used maps and GIS layers to work on site delineation and rationalise site boundaries, especially where triggering events produced partially overlapping sites and/or sites; standardised spellings of each site name were also agreed.

The KBA Partnership has agreed that existing site designations such as Important Bird Areas (IBAs), Important Plant Areas (IPAs) and Alliance for Zero Extinction (AZE) sites will continue to be recognised as KBAs where they meet the global criteria. No AZE sites are currently recognised in the Arabian Peninsula (an AZE review is under way). IBAs have been identified in all eight countries of the Arabian Peninsula; 131 in total (summary in Table 4).

A number of IPAs have been identified in the Arabian Peninsula. The qualifying criteria for IPAs differ in some characteristics from those used for KBAs. Therefore, the plant-working group reviewed a subset of IPAs against all the KBA criteria to examine where these sites also met the KBA criteria.

The taxonomic groups then reconvened to discuss the challenges of applying the KBA criteria at a regional level, for example, by adjusting the thresholds. Each group tested the criteria at the regional level using various approaches against several species and recommendations of how the criteria could be applied at a regional level were summarised.

Next steps

The full results of workshop are still being analysed and will be published later in 2018. Future Sharjah workshops will aim to apply the remaining criteria to an expanded subset of species, including all the trees, and once the conservation assessment of all endemic plants in the region held concurrently during this workshop plants, is complete.

Table 1 KBA Criteria Summary[2].

A. Threatened biodiversity		
A1 Threatened species		
A1a	≥0.5% global population and ≥5 reproductive units (RU) of a CR/EN species	(i) # mature individuals (ii) area of occupancy (iii) extent of suitable habitat (iv) range (v) # localities (vi) distinct genetic diversity
A1b	≥1.0% global population and ≥10 RU of a VU species	
A1c	≥0.1% global population and ≥5 RU of CR/EN species due only to past or current decline [= Red List A1, A2, A4]	
A1d	≥0.2% global population and ≥10 RU of a VU species due only to past/current decline [= Red list criteria A1, A2, A4]	
A1e	Effectively the entire population of a CR/EN species	
A2 Threatened ecosystem types (see IUCN 2016)		
B. Geographically restricted biodiversity		
B1 Individual geographically restricted species	≥10% of global population and ≥10 RU	((i) # mature individuals (ii) area of occupancy (iii) extent of suitable habitat (iv) range (v) # localities (vi) distinct genetic diversity
B2 Co-occurring geographically restricted species	≥1% of global population of ≥2 species in a taxonomic group or 0.02% of the global number of species in the taxon group, whichever larger	
B3 Geographically restricted assemblages		
B3a	≥0.5% global population of each of a number of ecoregion-restricted species in a taxonomic group: ≥5 species or ≥10% of the species, whichever larger.	(i) # mature individuals (ii) area of occupancy (iii) extent of suitable habitat (iv) range (v) # localities
B3b	≥5 RU of ≥5 bioregion-restricted species or 30% of the bioregion-restricted known from the country, whichever is larger	
B3c	Site is part of the globally most important 5% of occupied habitat for ≥5 species in the taxon group	(i) density of MI (ii) relative abundance of MI
B4 Geographically restricted ecosystem types (see IUCN 2016)		
C. Ecological integrity		
	Site is one of ≤2 per ecoregion with intact ecological communities	Composition and abundance of species and interactions
D. Biological processes		
D1 Demographic aggregations		
D1a	≥1% of global population of a species, over a season / during ≥1 key stage in life cycle	# mature individuals
D1b	Site is among largest 10 aggregations of the species)	# mature individuals
D2 Ecological refugia	Site holds a significant % of global population during environmental stress	# mature individuals
D3 Recruitment sources	Predictably produces larvae/juveniles that maintain ≥10% of the species	# mature individuals
E. Irreplaceability through quantitative analysis (see IUCN 2016)		

[2] Adapted from IUCN (2016) A Global Standard for the identification of Key Biodiversity Areas Version 1.0. First edition. Gland, Switzerland: IUCN.

Table 2 A list of globally threatened species for the region with information on their status taken from the IUCN Red List of Threatened Species.

Species	Red List Category		Global Population size	Global Range size
Reptiles				
Uromastyx aegyptia	VU	A2, A4	??	2 940 379
Uromastyx thomasi	VU	A2, A4	??	69 302
Acanthodactylus ahmaddisii	EN	B1	??	4 776
Acanthodactylus felicis	VU	B1	??	17 867
Asaccus montanus	VU	D2	??	3 364
Caretta caretta	VU	A2	36 000-67 000 nesting females	Oceanic
Chelonia mydas	EN	A2	??	Oceanic
Eretmochelys imbricata	CR	A2	??	Oceanic
Hemidactylus dracaenacolus	CR	B1	??	25
Lepidochelys olivacea	VU	A2	??	Oceanic
Asaccus caudivolvulus	LC*	B1	??	?
Phoenicolacerta kulzeri	EN	B2	??	500
Amphibians				
Duttaphrynus scorteccii	VU	D2	??	202
Birds				
Chlamydotis macqueenii	VU	A4	50 000-99 999	
Phalacrocorax nigrogularis	VU	A2, A3, A4, B2	220 000	
Buteo socotranus	VU	D1	250-500	Endemic to Socotra
Acrocephalus griseldis	EN	A3	1 500-7 000	
Passer hemileucus	VU	D1	800	Endemic to Abd Al Kuri island
Torgos tracheliotos	EN	A2, A3	5 700	
Gyps rueppelli	CR	A2, A3	22 000	x
Mammals				
Oryx leucoryx	VU	D1	1 000	24 064
Gazella arabica	VU	C2	10 000	
Gazella marica	VU	C2	2 100	
Arabitragus jayakari	EN	C2	2 500	
Capra nubiana	VU	C1, C2	<10 000	
Panthera pardus	VU	A2	??	
Dugong dugon	VU	A2, A4	<4 000	860 000
Nesokia bunnii	EN	A2	??	
Meriones sacramenti	VU	B1	??	20,000
Plants				
Aloe abyssicola	VU	D2	>1 000	1 locality
Aloe serriyensis	VU	D2	?	1 locality, AOO = 84 km²
Aloe whitcombei	EN	D	<250, possibly less than 5 RUs	1 locality
Blepharis dhofarensis	VU	B1+2	?	Endemic to coastal fog woodland of south coast of Oman and Yemen.
Anogeissus dhofarica	EN	B2	?	Endemic to coastal fog woodland of south coast of Oman and Yemen.
Boscia arabica	VU	B2	?	Found between the coastal plain and escarpment of southern Yemen and Oman

Table 3 A summary of the number of provisional sites and triggering species examined.

Location		Triggering events				
Subregion	Sites	Birds	Herpetofauna	Mammals	Plants	Total
1. Bahrain, Kuwait, Qatar, north and central Saudi Arabia, UAE	18	4	7	16	-	27
2. Oman, SW Saudi Arabia, Yemen	30	1	7	28	7	43
3. Jordan, Lebanon, Iraq, Syria	8	-	2	7	-	9
Total	**56**	**5**	**16**	**51**	**7**	**79**

Table 4 Global IBAs in the Arabian Peninsula.

Country	Number of sites
Bahrain	3
Jordan	10
Kuwait	4
Oman	24
Qatar	3
Saudi Arabia	29
United Arab Emirates	10
Yemen	48
Total	**131**

Technical Theme

Drones for Ecology in the Arabian Peninsula

Drone use in ecology, referred to as *eco-drones* or *conservation drones*, is still in its early stages, with the development of user groups and the exploration of applications.

An eco-drone is essentially a model aircraft with an autopilot system. The key is the payload; a drone is a mobile platform for cameras and other optical and other sensors, able to access sites in difficult terrain. While the operation of a drone is relatively easy, the standardised collection and analysis of useful ecological data can be complex. One of the great advantages of drone-based data collection is the ability to precisely program flight paths, enabling accurate repeated surveys to generate robust long-term datasets to evaluate change over time or in response to perturbation or to management.

The Drone Ecologists Research Network (DERN) was established in 2017 as an eco-drone user group representing both private and government agency staff across the United Arab Emirates (UAE). The use of drones for ecological monitoring to inform conservation management is relatively new in the Arabian Peninsula. Some of the challenges facing the use of eco-drones in the region include a limited understanding by many conservation managers of the capacity of drone-based monitoring; the relatively few people who are comfortable with the often complex data analyses required to fully exploit the technology, and a changing regulatory environment whereby the relatively low impact requirements of ecological monitoring are not appreciated by policy makers concerned with more impactful commercial applications of drones.

The purpose of the drone technical session at the 19th SICFAB was to start to expose the regional conservation community to the capacity and feasibility of drone-based data collection. The projects summarized below cover a range of applications for the application of both quad-copters and fixed wing drones (Figure 2), for vegetation monitoring, counts of shorebirds and of turtles, and monitoring of herd dynamics in Arabian oryx. Delegates discussed the opportunities, constraints, and challenges relating to the expansion of drone-based ecological monitoring in the Arabian Peninsula region.

The SICFAB organisers would like to thank the members of DERN for sharing their knowledge. The case study summaries below have been compiled from notes and presenter's slides; any errors are therefore the responsibility of the editors.

Figure 2 Types of fixed-wing and quad-copter drones used in ecological monitoring in the UAE (not shown to relative scale).

Top left: eBee fixed wing drone (~700g)	http://uav.vgt.vito.be/
Top right: DJI Inspire 2 drone (~3000g)	https://www.dronesdirect.co.uk/
Bottom left: DJI Phantom drone (~1200g)	https://www3.djicdn.com/
Bottom right: DJI Mavic Pro drone (~743g)	https://www.amazon.com/

Ecological Surveys Using a Fixed Wing Drone

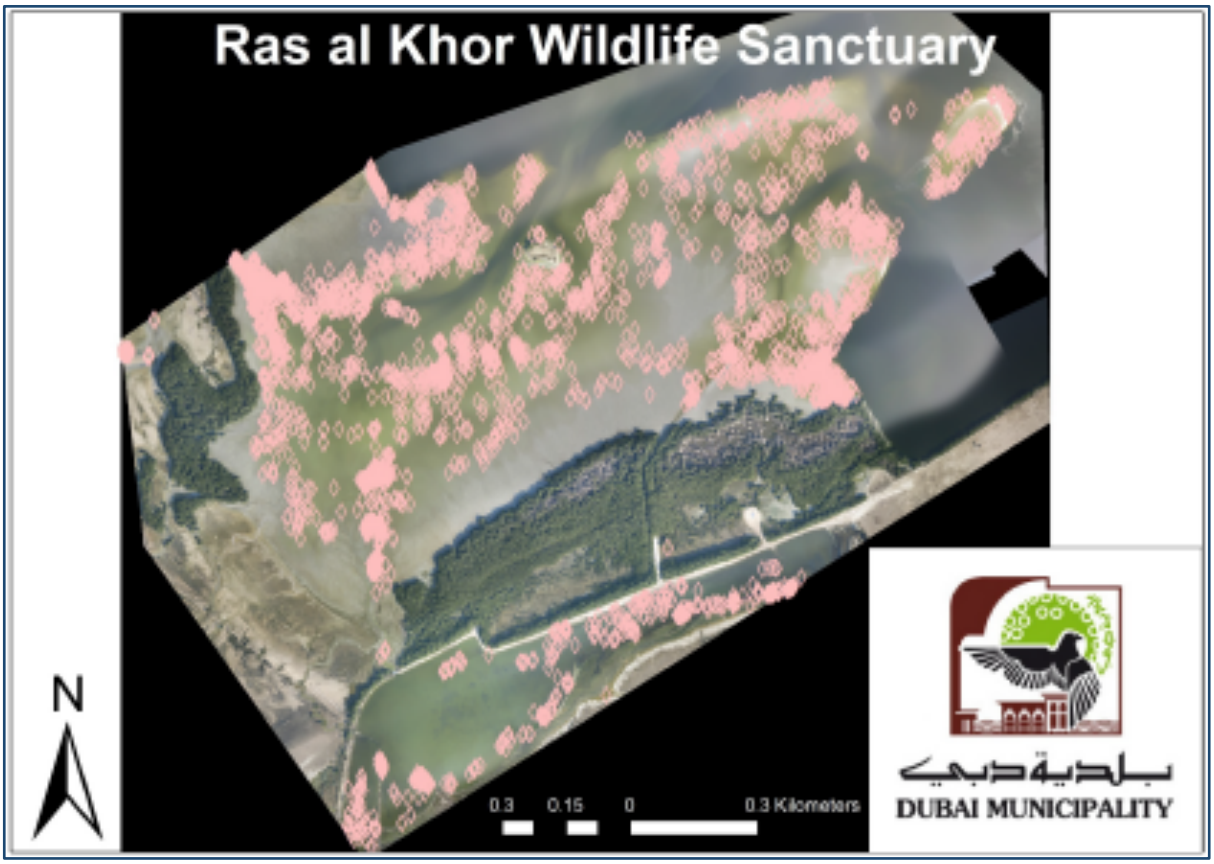
Tamar Khafaga and Greg Simkins, Dubai Desert Conservation Reserve, Dubai, UAE

The eBee fixed-wing drone (Figure 2), with RGB, IR and multi-spectral sensors, and applying eMotion 2 for pre-flight planning and Pix4D for post-flight data processing, has been used for a variety of ecological data collection over the last 4 years in Dubai, including a survey of Ghaf trees and Dhab burrows, monitoring of vegetation change in relation to nature-based tourism, and counts of flamingoes in wetland areas.

The flamingo count involved two flights over 5.5 km^2 of the Ras al Khor Wildlife Sanctuary, using RGB and NIR imagery obtained from an altitude of 350 m AGL and achieving a resolution of 12 cm. Over 200 images were obtained per flight and used to create two ortho-images. Individual birds were identified and marked on the image and shape files were created to enable a robust total count of 4 306 birds (Figure 3).

Figure 3 Drone based census of flamingoes in the Ras al Khor Wildlife Sanctuary, Dubai, UAE.

Pink dots represent shape files derived by manually marking of the image of individual birds.



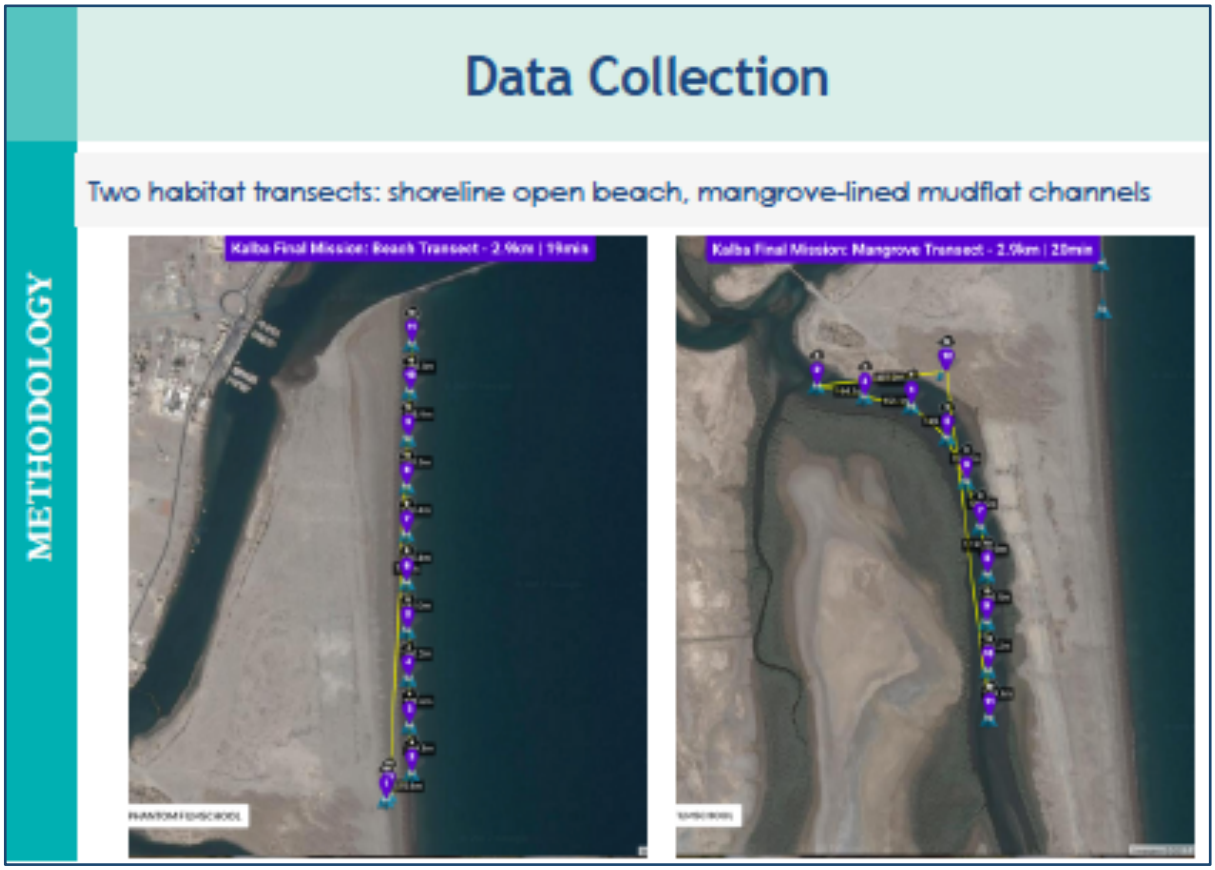
Use of Drones in Counting Coastal Shorebirds in UAE

Sonya Benjamin, AESG Specialist Consultancy and Commissioning, Abu Dhabi and Dubai, UAE

Ground-based surveys of shorebirds face a number of challenges that could be overcome if an aerial view of the survey sites was possible to obtain. Drone-based image acquisition has been used to count seabirds in colonies, herd animals, and marine fauna, and even to check nest contents. Drones provide access to difficult-to-navigate terrain, and can yield reliable, achievable images to support both current survey needs and retrospective analyses. One of the concerns with drone-based avian monitoring is the level of disturbance caused by low altitude drone flights, and the degree of bias this might introduce into survey results.

Two sites were selected in the Khor Kalba Conservation Area, Sharjah, UAE, to quantify the species-specific disturbance resulting from standardized drone flights over open beach and mangrove mudflat habitats (Figure 4). A Mavic Pro drone (Figure 2) was fitted with a tilted gimbal 4K video recorder and flown on repeated transects to explore the effect on mean bird flushing rates of drone velocity and altitude, and habitat. Above 15 m AGL flushing was eliminated, but associated loss of resolution at higher altitudes meant identification of smaller species of birds was not possible. Slower drone speeds cause fewer disturbances, but there is a trade off between speed and battery life; 10 kph was the optimal energy-disturbance trade off. Angle of approach, vertical change in altitude, drone position, and drone design can also affect flushing rates.

Figure 4 Pre-programmed drone flight transects in shoreline open beach and mangrove mud-flat habitats in the Khor Kalba Conservation Reserve.



Use of Drones vs Satellites for Desert Vegetation Assessment

David Gallacher, Department of Interdisciplinary Studies, Zayed University, Abu Dhabi, UAE

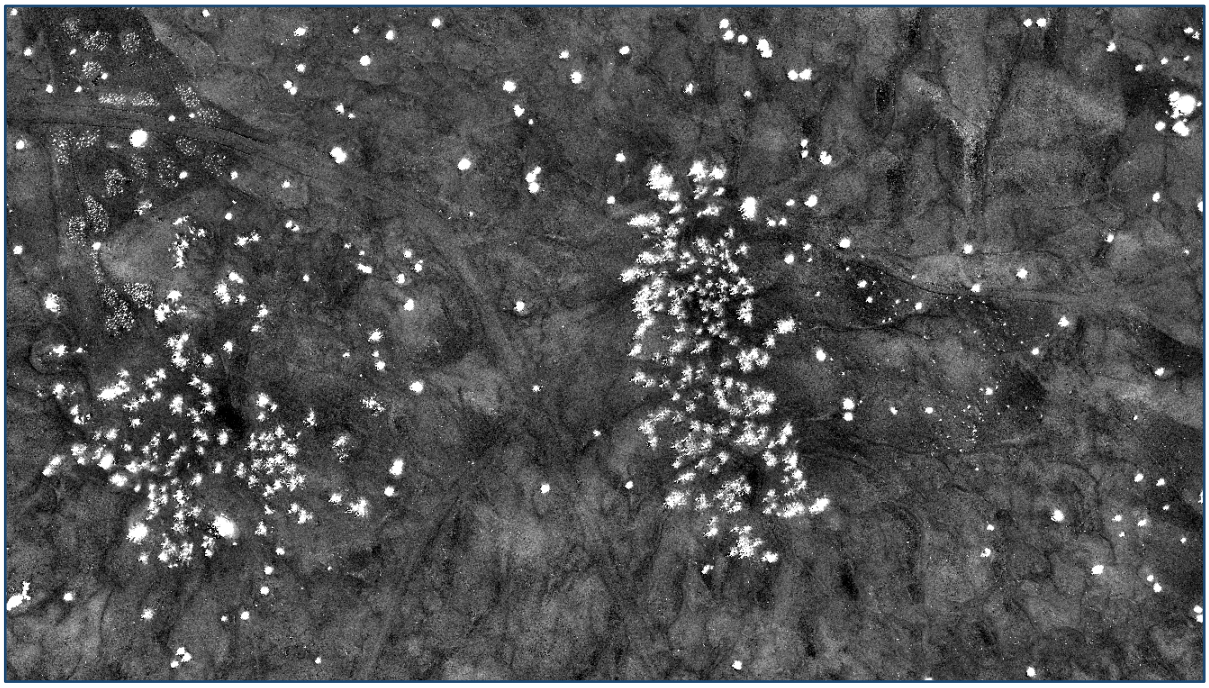
Normalized Difference Vegetation Index (NDVI) was developed in the 1970s to quantify vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). NDVI uses the NIR and red channels in its formula:

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

Healthy vegetation (chlorophyll) reflects more near-infrared (NIR) and green light compared to other wavelengths. But it absorbs more red and blue light. The formula generates a value between -1 and +1. If there is low reflectance (or low values) in the red channel and high reflectance in the NIR channel, this will result in a high NDVI value. And vice versa. Overall, NDVI is a standardised way to measure healthy vegetation. When you have high NDVI values, you have healthier vegetation. When you have low NDVI, you have less or no vegetation.

Rangeland degradation is a major concern in Arabia but historical data is lacking and large spatiotemporal variation makes long-term and permanent change difficult to assess. NDVI might not be the most appropriate means to assess vegetation in desert regions because NDVI value will be low, and could be masked by non-vegetative components (Figure 5). There are plans to explore the use of no-vegetation NDVI baseline measurements to better evaluate low-vegetation readings, by deriving data from satellite images, ground surveys, and drone-based image acquisition. The aim is to determine if NDVI estimates correlate with on-ground measurements, and whether NDVI estimates above baseline are consistent at different images resolutions.

Figure 5 Drone-based image of desert vegetation, indicating how low Normalized Difference Vegetation Index (NDVI) values can be swamped by large trees and non-vegetative readings.



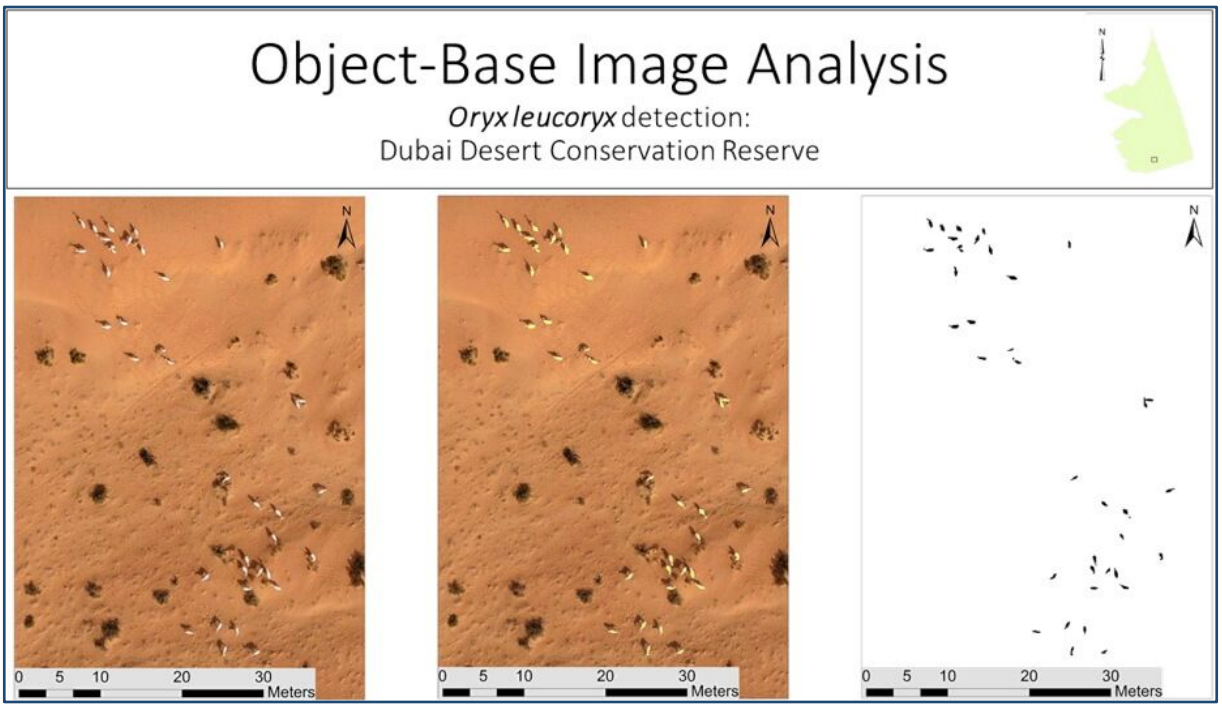
Using UAV Data to Monitor Herd Dynamics of Reintroduced Arabian Oryx in the UAE

Meyer De Kock, Czech University of Life Sciences, Prague, Czech Republic (in collaboration with Declan O'Donovan Wadi Al Safa Wildlife Centre)

This study explored whether low altitude drone imagery transformed by geo-rectification and data extracting via OBIA and analysed by GIS-based statistical software, could be used as a useful non-invasive tool for monitoring a reintroduced Arabian oryx population. An estimated 400 000 m^2 can be covered during a single 17 min flight at 150 m AGL and with an 80% overlap of single images. The goal will be to obtain the most extensive possible coverage of the herd, within the limited range of the UAV. A spectrometric analysis of oryx coats was conducted to identify the reflective characteristics and train Object Based Image Analysis (OBIA)software to recognise Arabian oryx from drone-derived images (Figure 6) taken within the DDCR using a DJI Inspire 2 (Figure 2) with Zemusse X5S camera. Flight planning was with Dronedeploy, set to a height of 100 m and maximum sped set to 15 m/s.

The data acquired by this technique can improve the understanding of the herd dynamics of re-introduced Arabian oryx, in turn, provide guidance in the management strategies for better success in the introduction process of this species. Therefore, the research will contribute to the long-term conservation of the species and insight into the social structure and how the reintroduced Arabian oryx herds interact with their environment.

Figure 6 Aerial drone based image of Arabian oryx in the Dubai Desert Conservation Reserve, Dubai, UAE; raw image (left), object based image analysis (OBIA) detection of individual oryx (center), and resulting shapefile with background removed and only oryx objects visible (right).



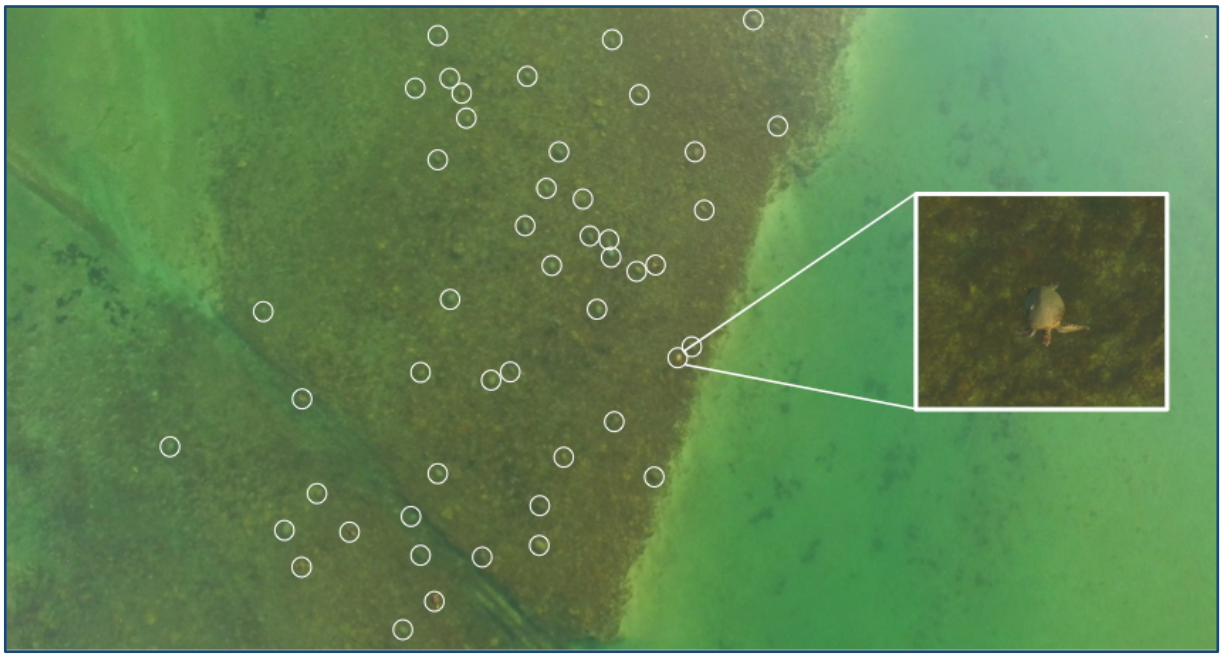
Use of Drones in Studying Turtle Populations in Khor Kalba Conservation Reserve, Sharjah, UAE

John Pereira, Environment and Protected Areas Authority, Sharjah, UAE.

Khor Kalba is a 2500 ha protected area on the border between UAE and Oman, conserving an important mangrove habitat that supports a number of regionally rare species. Three turtle species have been recorded in the reserve, but ground-based surveys are not able to yield reliable estimates of the number of turtles using the area. A rough estimate was in the order of around 20 turtles, but initial flights with a Phantom drone suggested this might be a gross under-estimate (Figure 7).

Litchi software was used for flight planning to set waypoints, altitudes and speed to fly repeated standardised transects to identify turtle hotspots for targeted management. Surveys indicated in excess of 200 turtles, mostly green turtles, were visiting the protected area daily.

Figure 7 Drone-based image of green turtles (individuals highlighted by circles) over rocky reefs in the Khor Kalba Conservation Reserve, Sharkah, UAE.



The drone was also used for real-time coordination of a trial turtle catching exercise, to direct a ground team to move turtles into a net (Figure 8). There are plans to expand capture operations in order to tag (Figure 9) and track a larger sample of turtles.

Figure 8 Drone-directed turtle catching in Khor Kalba Conservation Area.

The red circle indicates the position of a turtle visible only to the drone operator, who directed a ground crew to move forward (red arrows) and direct the turtle into a net strung across the waterway (white dots).

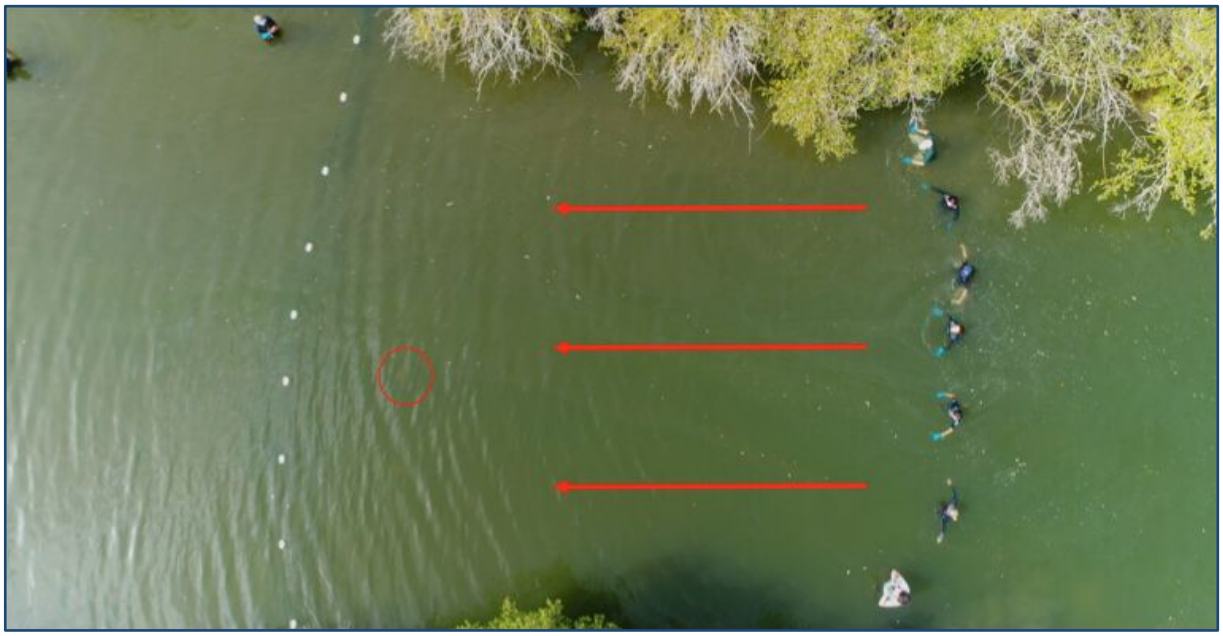


Figure 9 Sampling and tagging a green turtle captured during a drone-directed operation in Khor Kalba Conservation Area, Sharjah, UAE.

Veterinary Theme

Haematology of Non-domestic Mammals

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Introduction

Haematological examination, or the complete blood count, is an important diagnostic tool used widely in veterinary medicine of domestic species. Information about the use of haematology in non-domestic species is patchy. Although the basic principles of haematology, as applied in domestic species, can for the most part be applied to non-domestic mammals, some differences do exist.

In this workshop, principles of interpretation of a complete blood count (CBC), including examination of blood smears, were reviewed, and species-specific points of interest were discussed. Case studies were used to illustrate application of information obtained from a CBC. There was also a practical session on how to prepare and stain a blood smear for examination.

Analysers and Species Settings

Some of the delegates had in-clinical haematology analysers (IDEXX Procyte and Abaxis Vetscan), while the rest were using commercial laboratories in the region.

Delegates were aware that haematology analysers do not have species-settings for most non-domestic mammals, and that analytical errors and the generation of incorrect results may occur.

The following protocol was discussed:

1. Check existing literature for data on mean cell volume (MCV). If peer-reviewed, dependable information is available on MCV, then choose a species on the analyser with the closest MCV. If no information is available, several settings may have to be tried.
2. Perform a microhaematocrit and use packed cell volume (PCV) value as the gold standard. This PCV should be reported as the haematocrit.
3. The species result with the haematocrit nearest to the PCV is likely to be the most accurate. The white blood cell count, red blood cell count (RBC), haemoglobin (HGB) and platelet counts can be used.
4. MCV is then calculated: PCV/ RBC.
5. MCHC is calculated: HGB/PCV.
6. The automated differential count will not be accurate and manual differential count should be performed from the blood smear.

Recent publications suggest that camelid blood should be measured under the horse setting, followed by steps 2-6 above.

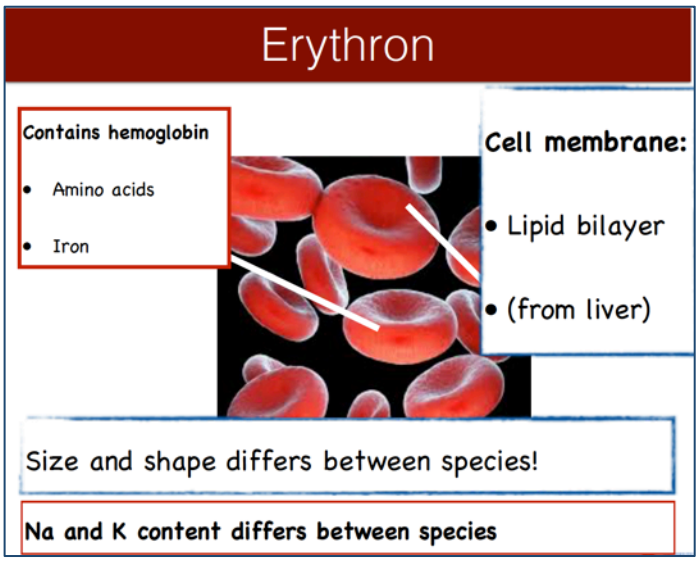
Complete Blood Count

The CBC consists of evaluation of the erythron, leukon and thrombon. For more information please consult the online resource eclinpath.com.

Erythron

Erythrocytes are formed in the bone marrow through the process of erythropoiesis, which is partially dependant on adequate levels of iron, amino acids and phospholipids. Erythropoietin is the hormone responsible for erythropoiesis and is produced in the kidney. Erythrocytes are biconcave discs in most species (Figure 10), but there is a size variation. Camelids have oval erythrocytes. Cervids and some species of antelope have erythrocytes that are biconcave discs *in vivo* but have a sickle shape when smeared onto a blood smear.

Figure 10 Erythrocytes.



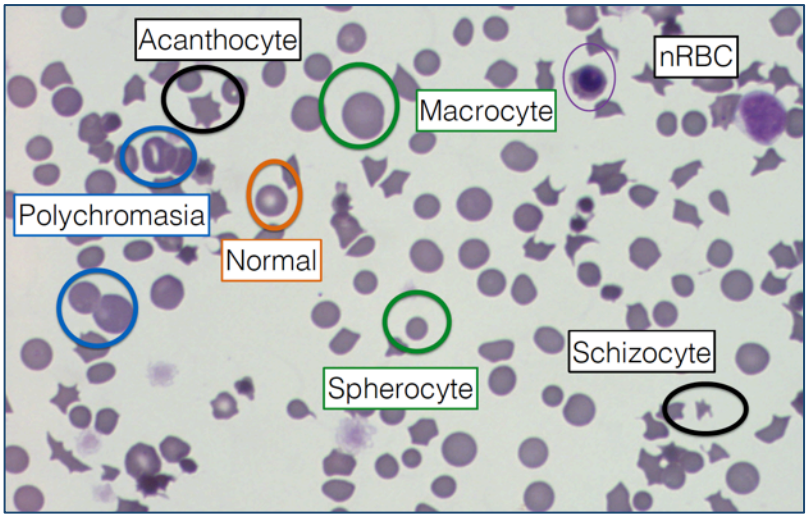
When evaluating erythrocyte morphology on a blood smear, attention must be paid to size, staining, shape and inclusions, as compared to a normal erythrocyte for that species. Some of the more important changes are (Figure 11):

1. Microcytosis – cells are smaller than normal. Seen in iron-deficiency anaemia and porto-systemic shunting.
2. Macrocytosis – cells are larger than normal. Seen in regenerative anaemias and folate/ cobalamin deficiency.
3. Hypochromasia – reduced haemoglobin content as evidence by increased central pallor. Seen in iron-deficiency.
4. Polychromasia – blue tinge to the erythrocyte. Represents reticulocytosis/regeneration.
5. Fragmentation changes – shizocytes, acanthocytes. Seen in iron-deficiency anaemia and microangiopathies.
6. Inclusions include basophilic stippling, Heinz bodies and haemoparasites.

One of the most common changes seen in the erythron is a decrease in red cell mass, as evidenced by a decrease in haematocrit, haemoglobin concentration and red cell count. Anaemia is classified as regenerative, if there is an increase in reticulocytes/polychromasia, or as non-regenerative, if these changes are absent.

Causes for a regenerative anaemia are either blood loss or haemolysis. Non-regenerative anaemias can occur secondary to inflammation, chronic kidney disease, bone marrow disease or in the acute stages of blood loss.

Figure 11 Examples of changes to erythrocyte morphology.

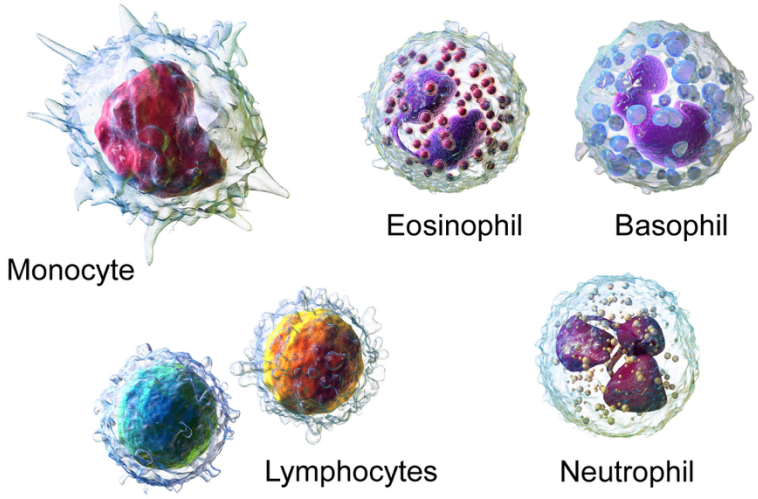


Leukon

Leukocytes consist of neutrophils, lymphocytes, monocytes, eosinophils and basophils (Figure 12). It is of vital importance to identify band neutrophils and neutrophil toxic changes on a blood smear, as these may be the only indicators of inflammation in some species. Blood smear findings and results from an automated count should be used to identify the following abnormal leukogram patterns:

1. Excitement/ adrenalin – mature neutrophilia, lymphocytosis, no left shift or toxic change
2. Stress/ cortisol – mature neutrophilia, monocytosis, lymphopenia, eosinopenia, no left shift or toxic change
3. Acute inflammation – mature and band neutrophilia (i.e., left shift), lymphopenia, toxic change
4. Acute inflammation in ruminants/ overwhelming inflammation in other species – mature neutropenia, left shift, lymphopenia, toxic change.

Figure 12 Leukocytes.



Source: Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1(2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436.

Thrombon

The blood smear should always be examined to confirm platelet numbers. Platelet clumping will result in falsely low platelet counts and can be detected on the feathered edge of the blood smear.

CBC Characteristics Pertinent to Different Animal Groups

Carnivores

CBC interpretation is largely based on principles applied to domestic dogs and cats. Felid platelets become activated very easily during blood collection and platelet clumping may be a common problem in this group.

Camelids

Erythocytes are oval, flat and small. MCV is low and red cell counts and MCHC higher than other mammals. Iron deficiency results in dacrocytes, hypochromasia and uneven haemoglobin distribution.

Perissodactyls

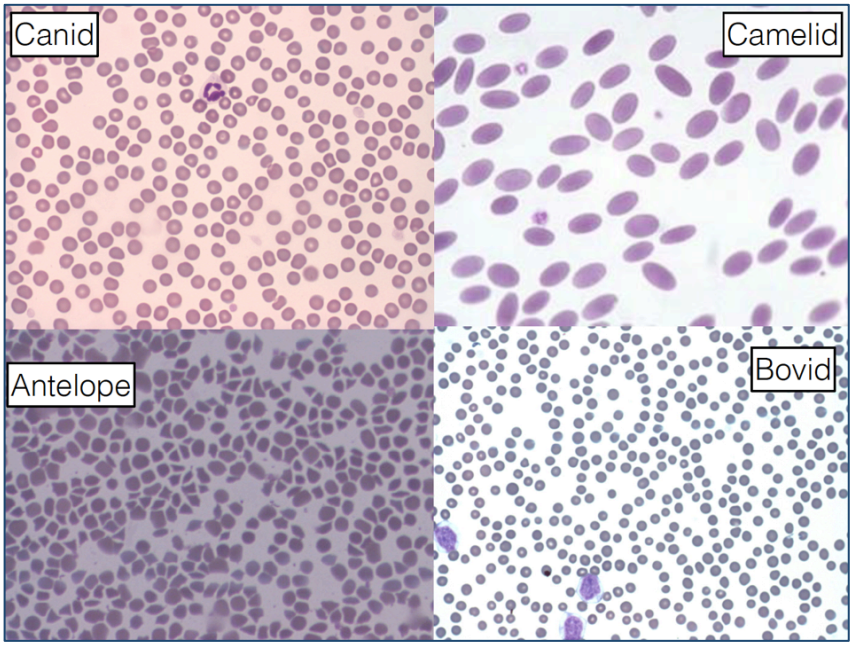
Domestic horses and some rhinoceros species have high potassium in the erythrocytes, which may cause a pseudohyperkalaemia if there is haemolysis in the clinical chemistry sample. It is not unusual to find Heinz bodies in the blood smear of black and white rhinoceros.

Ruminants

The bone marrow reserve of mature and band neutrophils is low compared to other groups, which results in a neutropenia during the first 48-72 hours of inflammation. A neutrophilia and left shift should follow after this time. As opposed to most other groups, the lymphocyte is the dominant leukocyte in peripheral blood.

Figure 13 provides illustrated examples of red blood cell morphology across different mammal groups.

Figure 13 Examples of erythrocyte morphology in different mammals.



Clinical Chemistry of Non-domestic Mammals

Dr EH Hooijberg, BVSc CertSAP(GP) DiplECVCP, Department of Companion Animal Studies, Faculty of Veterinary Science, University of Pretoria, South Africa

Introduction

Clinical chemistry panels are used often in veterinary laboratory medicine as part of a minimum database, for pre-anaesthetic screening or during annual health checks, for diagnosing specific diseases and for monitoring response to treatment.

The purpose of this workshop was to revise the basic approach to clinical chemistry interpretation and to discuss differences pertinent to different groups of non-domestic mammals. Several case studies illustrating the concepts presented in the first lecture were given to attendees to discuss in small groups. This was a very constructive exercise as those delegates with more experience in the field were able to share some of their experience with younger colleagues.

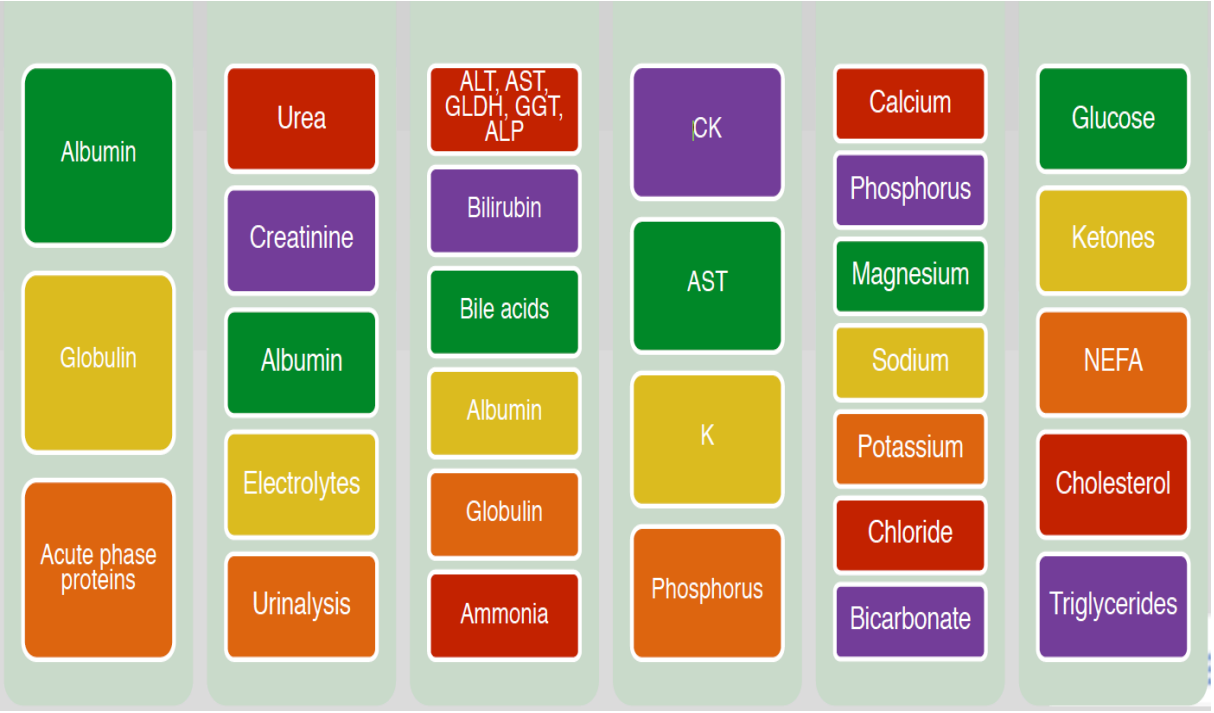
Analytical Considerations

Clinical chemistry assays may be performed from either serum or heparin plasma. For most analyses, the analytical methods used are accurate across species. Problems arise when interpreting results, as reference intervals are often not available or are based on a variety of analytical methods and populations. This results in a very wide "normal" range, leading to abnormal results being missed. Most delegates were using the Species360/ ZIMS database for reference intervals and were aware of these limitations.

A System-based Approach to Clinical Chemistry Interpretation

Analyses can be grouped in order to assist interpretation (see Figure 14).

Figure 14 A system-based approach to clinical chemistry interpretation: grouping abnormalities.



Basic clinical pathology aspects of these analyses were discussed in the context of this systematic approach. Further general information on these analyses, apart from SDMA and acute phase proteins, is not provided in this report but can be found in the lecture pdfs, or general clinical pathology textbooks. The website eclinpath.com is an open education resource presented by the Cornell University College of Veterinary Medicine and has dependable, accurate information on the clinical chemistry topics discussed above.

Acute phase proteins

Acute phase proteins (APPs) are proteins produced mainly in the liver that either increase (positive APPs) or decrease (negative APPs) during systemic inflammation. Major positive APPs include C-reactive protein (CRP), serum amyloid A (SAA) and haptoglobin (Hp). Albumin is a negative APP and decreases during inflammation. The APP response occurs very quickly during inflammation, with changes in major APPs occurring before changes in the leukogram. APPs have been used in domestic animals at both an individual and herd level for the last decade to detect and monitor inflammation and health status and may be useful for non-domestic species. Some research has been done in this regard and is reported for each animal group in the section below.

Unfortunately, there are difficulties with assaying some of these proteins, due to differences in protein structure across animal groups, and the availability of validated assays. Some delegates reported that a laboratory in the region offered SAA. Further research on the use of APPs in non-domestic species in the region would be extremely valuable.

Symmetric dimethylarginine (SDMA)

SDMA is an amino acid produced by all cells in the body, at a constant rate, and is then excreted by the kidney. The rate of renal excretion is directly related to the glomerular filtration rate, which is a function of renal blood flow and the number of functioning nephrons. SDMA, like creatinine, is therefore a marker of glomerular filtration rate (GFR) but has been found to be more sensitive for a decrease in GFR than creatinine – SDMA increases with a 40% decrease in GFR compared to creatinine which decreases only at 75% decrease in GFR. SDMA has been found to be an early marker of renal disease in dogs and cats. SDMA holds promise for the diagnosis and monitoring of renal disease in non-domestic carnivores, particular cheetahs. SDMA is currently only offered by Idexx reference laboratories, of which there are none in the region.

Clinical Chemistry Considerations Pertinent to Different Animal Groups

Carnivores

SAA and Hp have been reported as major APPs in cheetahs, lion, ocelots, tigers and leopards. A recent study found that cheetahs with health problems and renal disease had higher SAA concentrations than healthy cheetahs. Increased SAA may serve as a marker for, and contribute to, the pathogenesis of renal amyloidosis in this species.

In a retrospective study, SDMA was found to increase 22 months before creatinine in 5 out of 7 cheetahs with chronic kidney disease.

Camelids

Old-World camelids are able to tolerate dehydration states of up to 30%. They will develop a pre-renal azotaemia after racing or long periods without drinking and are susceptible to developing acute kidney injury if, for example, NSAIDs are administered during these times.

Camelids have higher glucose and lower insulin levels than other species, and appear to be particularly prone to developing disorders of fat and energy metabolism during periods of negative energy balance. Syndromes include hyperglycaemia, hyperlipidaemia and hepatic lipidosis. A panel consisting of beta-hydroxybutyrate, non-esterified fatty acids, triglycerides, AST, GGT and ALP would be useful for diagnosis of these syndromes.

SAA and Hp appear to be major APPs in the dromedary camel.

Perissodactyls

SAA and Hp are major APPs in the domestic horse and SAA may be used in zebras and possibly Przewalski's horses. Acute phase proteins in the white rhinoceros are currently under investigation.

Hypercalcaemia may be an early indicator of renal disease.

Ruminants

In terms of APPs, SAA and Hp have been used in impala, Arabian oryx and blackbuck, and Hp may be useful in giraffe.

Capture myopathy is an important and usually fatal syndrome that may develop as a consequence of immobilisation. Clinical chemistry changes always include marked increases in CK and AST activity. Hyperkalaemia, metabolic acidosis due to hyperlactatemia, azotaemia and myoglobinuria may also be seen.

Case Discussions

Cases included a cheetah with renal amyloidosis, a snow leopard with hepatic insufficiency due to veno-occlusive disease, a white rhinoceros with capture myopathy and a herd of gazelles with pyrrolizidine alkaloid toxicity.

Delegates were encouraged to look at serial changes on clinical chemistry reports, as reference intervals are not always helpful. In particular, changes in creatinine of more than 30% in a hydrated animal should raise suspicion for renal disease.

Cytology of Non-domestic Mammals

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Introduction

Cytology is a diagnostic tool commonly used in companion animal practice to evaluate the cellular composition of organs, fluids and mass lesions. It has the advantages of being cheap, with quick, easy and safe sampling methods. Interpretation can be hampered by the lack of tissue architecture and poor sample quality.

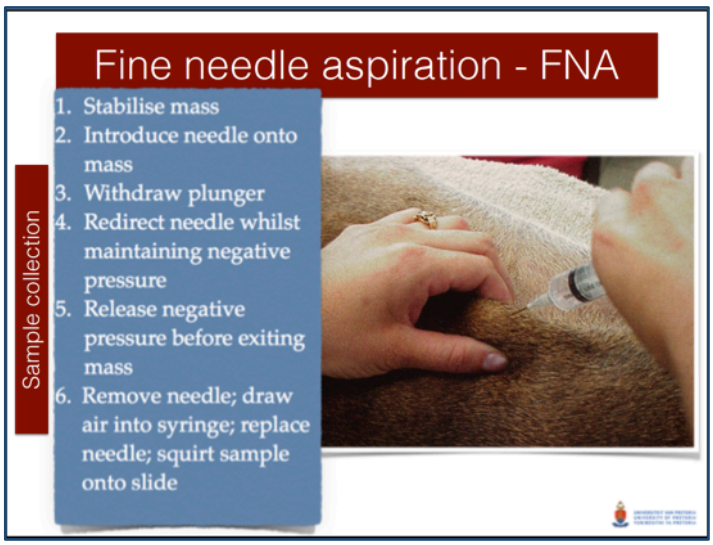
Delegates at the workshop said that they do not commonly use cytology at present, and therefore this skill could be targeted for further development in the region.

This workshop covered cytological sampling techniques and basic principles of evaluation.

Sampling Methods

The most common method of acquiring sample material is a fine needle aspirate, using a 22-24G needle and 3-20 mL syringe (Figure 15). The technique can be performed using suction or can be done without suction for fragile tissues like lymph nodes, spleen and liver. Once material has been collected in the hub of the needle, it should be carefully squirted onto a clean glass slide. The material is then spread out into a monolayer using the squash or blood smear technique.

Figure 15 Collecting samples for analysis: Fine needle aspiration.



Another method of preparing samples is to make impression smears, usually from biopsy samples (Figure 16). The surface of a tissue biopsy is pressed onto a clean glass slide over several areas, after carefully blotting away excess blood with paper towel.

Less commonly used sample collection methods include scrapes and swabbing (Figure 17 and Figure 18). Buffy coat smears are advised for bloody material, in order to concentrate nucleated cells of interest.

Figure 16 Collecting samples for analysis: Impression smears.

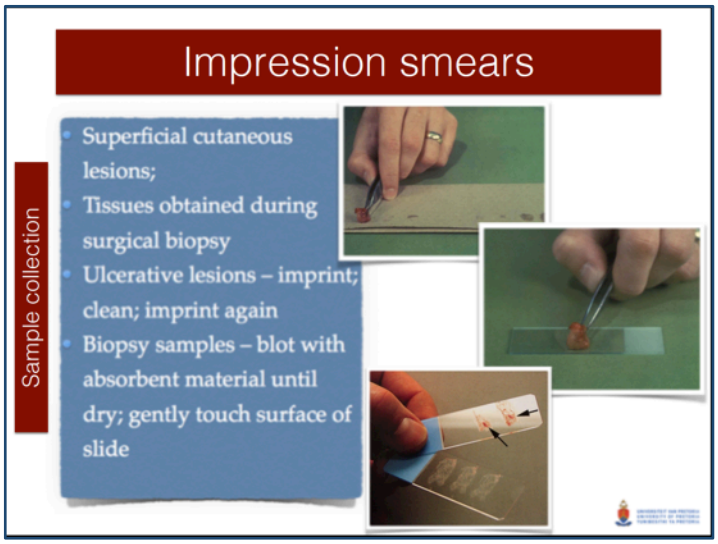


Figure 17 Collecting samples for analysis: Scrapings.

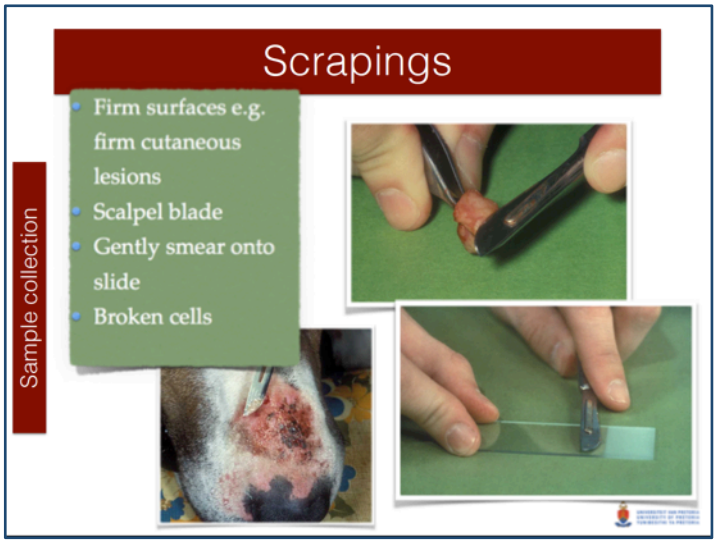
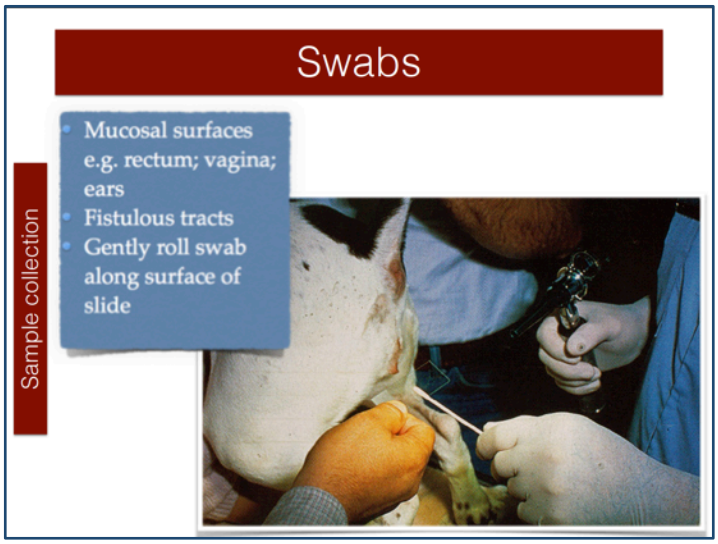


Figure 18 Collecting samples for analysis: Swabs.



Once slides have been prepared, they can be stained with Diff-Quik and examined in-house. If slides are to be sent away for examination, they should be placed unfixed and unstained into a plastic slide container, which is in turn sent off in a well-padded box. Cytology slides should never be placed into a refrigerator as water will condense on the glass and ruin the slides. Cytology slides should be kept separate from containers containing formalin, as formalin fumes interfere with the Diff-Quik staining reactions.

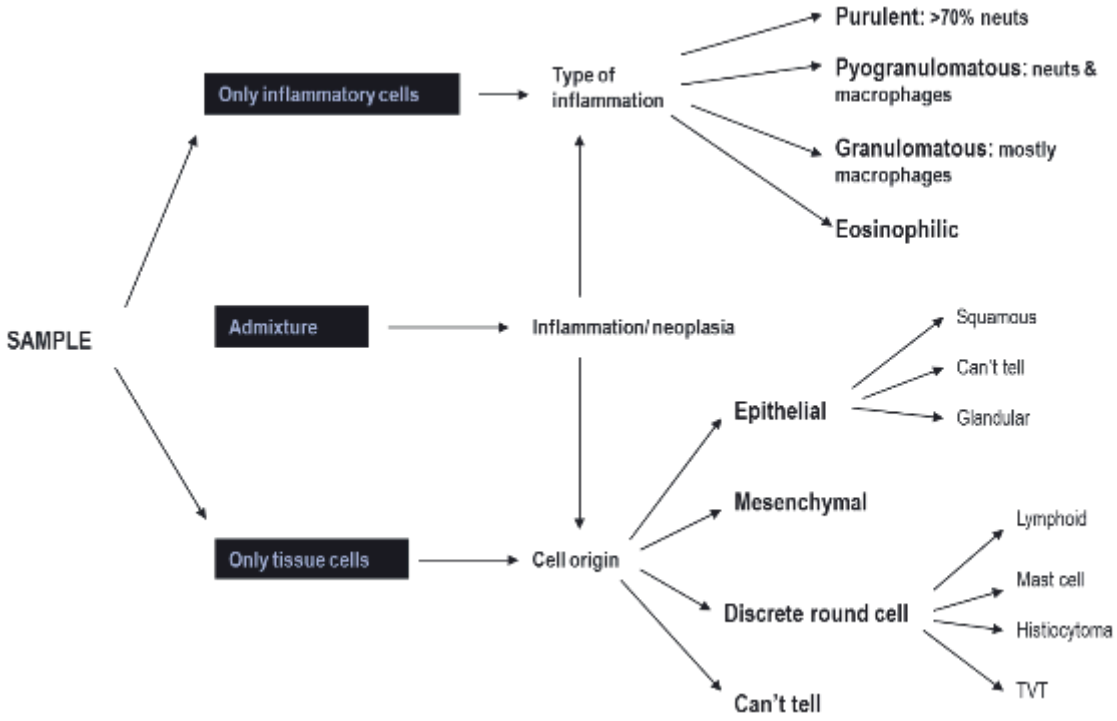
Sample Quality

Successful interpretation of cytological specimens is heavily dependent on the presence of adequate numbers of well-preserved cells. Smears with very low cellularity, marked haemodilution or lysed cells will inevitably be non-diagnostic. A gentle approach is needed to avoided cell lysis. Haemodilution can be minimised by using the non-aspiration technique. Cellular yield from mesenchymal masses is often poor and can be increased by using a bigger needle and more suction.

Approach to Cytological Evaluation

Accurate interpretation of cytological specimens is to a large extent dependent on pattern recognition and thus the experience of the cytologist. A basic approach is outlined in Figure 19.

Figure 19 Approach to interpretation of cytological specimens.



Cytology is a highly visual discipline, and numerous images with interpretations have been provided in the lecture pdfs.

During preparation of the material for the workshop, it was noted that there is a paucity of reports or research concerning the use of cytology in non-domestic species. Cytological changes are not, however, expected to differ much from those seen in domestic species.

Urinalysis of Non-domestic Mammals

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Introduction

Examination of urine can provide important information about the kidneys and lower urogenital tract. Urinalysis should form part of any health screening or minimum database.

In terms of urine collection, voided samples appeared to be the most common type that delegates acquired from their patients. These samples are adequate if environmental contamination is kept to a minimum. Collecting samples mid-stream would be optimal. If an animal is to be immobilised for veterinary procedures, urine can be collected by cystocentesis, bladder catheteriasation or by expression of the bladder.

Urinalysis

Organoleptic examination

Urine should be a shade of yellow, and clear (Figure 20). Equids and rabbits may have cloudy urine due to the presence of calcium carbonate crystals.

Figure 20 Organoleptic examination of urine.

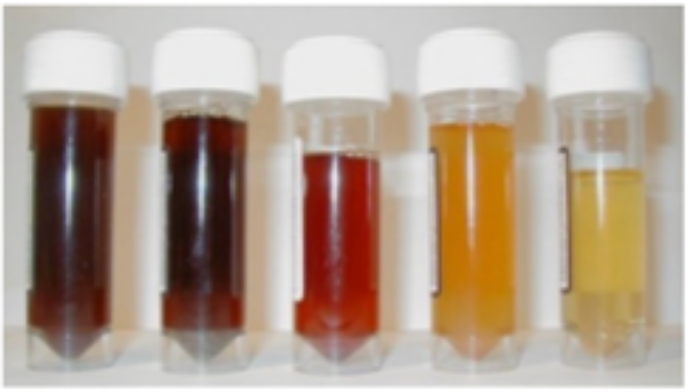
Colour:

Normal = yellow or amber (urochromes)

Red, red-brown = hemoglobin, myoglobin, blood

Brown to black = methemoglobin from hemoglobin , myoglobin

Yellow-orange/-brown/-green = bilirubinuria



Specific gravity

Urine specific gravity (USG) should only be measured using a refractometer. Delegates were reminded to calibrate their refractometers with distilled water weekly. USG gives an indication of the concentrating ability of the renal tubule. All cases with azotaemia should have USG evaluated. Animals with prerenal azotaemia due to dehydration are expected to have a high USG (very concentrated urine). An inadequate USG in the face of azotaemia is diagnostic for renal disease.

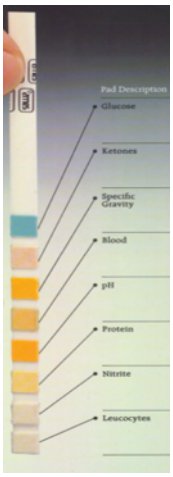
USGs considered adequate for domestic animals are:

Cats: > 1.035

Dogs: > 1.030

Ruminants/ horses: > 1.025

Dipstick/chemical analysis



The colour pads on the dipsticks are very sensitive to exposure to moisture and air. Ideally, dipsticks should be used/discarded within 30 days after opening the container. If this is not practical, then a second container can be used as the "in-use" container and filled with 10-15 dipsticks at a time. This will minimise handling and opening of the primary container.

Dipstick pads that are inaccurate/useless and should never be used in veterinary medicine are:

1. Specific gravity
2. Leukocytes
3. Nitrite
4. Urobilinogen

The useful pads are:

pH – normal ranges carnivores 6.0-7.5; herbivores 7.5-8.5.

Protein – should be negative. False positives occur in alkaline urine. Any protein reaction should be followed up by a sediment examination to investigate post-renal proteinuria and serum protein analysis to evaluate pre-renal proteinuria. If neither of these reveal a reason for the proteinuria, it is assumed to be renal in origin. A urine protein:creatinine ratio should be performed in order to quantify the proteinuria.

Glucose: glucoseuria may indicate diabetes mellitus, stress or proximal tubular pathology.

Ketones: ketonuria is an indication of a negative energy balance.

Bilirubin: Bilirubinuria is an indication of hyperbilirubinaemia, which should be further investigated (pre-hepatic, hepatic or post-hepatic).

Haem – a positive reaction can be caused by intact erythrocytes (haematuria), haemoglobin or myoglobin.

Sediment examination

A sediment is prepared by centrifuging 4-5 mL of urine, discarding the supernatant and placed 2 drops of sediment on a slide under a coverslip. A smear, stained with Diff-Quik, can also be prepared. The sediment is evaluated for the presence of casts, crystals, squamous epithelial cells, transitional epithelial cells, renal tubular epithelial cells, leukocytes, erythrocytes and bacteria. Further descriptions of the morphology of these sediment elements can be found in the lecture .pdfs, clinical pathology textbooks or eclinpath.com.

Urinalysis practical

The delegates had the opportunity to perform a full urinalysis on urine samples collected from a cow, baboon and hedgehog. There was also a competition to see which delegate could read the specific gravities for a range of urine samples, and other fluid samples most accurately.

Clinical Veterinary Immunology – Understanding Principles of Host Responses

Prof. M. Miller, DVM, MPH, PhD, Dipl. ECZM (ZHM); Stellenbosch University, Cape Town, South Africa.

Introduction

Immunology is the study of the immune system and its function in health and disease. It is important for survival of the host in a world filled with toxins, microbes, and foreign materials. Understanding the development of the immune response is essential for diagnosis, treatment and prevention, especially in terms of vaccination.

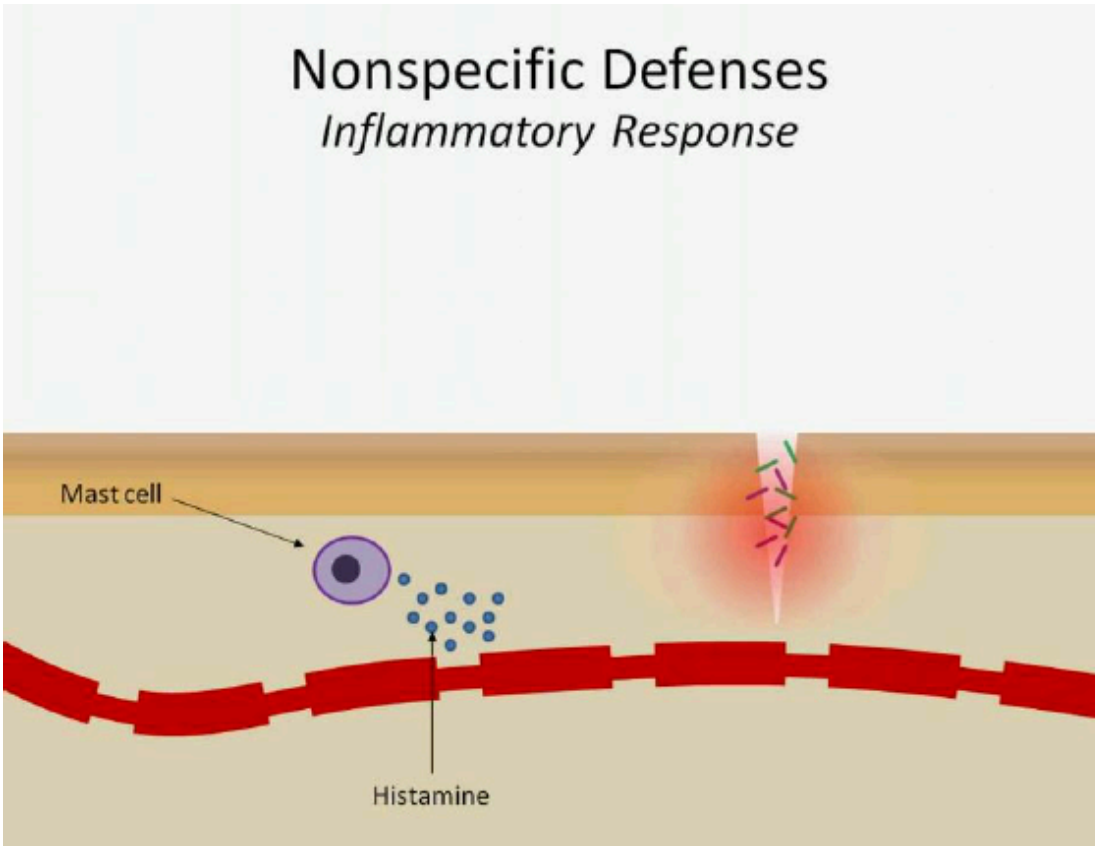
The innate immune response

The innate immune response is the first line of defense. The mechanism is nonspecific to the offending agent, and its primary role is prevention of infection or disease. This system consists of mechanical and chemical barriers, such as the skin, mucous membranes, antimicrobial proteins and phagocytic cells. If these barriers are evaded, an inflammatory response is activated. However, age, nutrition, stress, drugs, other diseases affect the effectiveness of this system and it is constantly changing.

The inflammatory response

The inflammatory response is what occurs in tissue as a result of injury (Figure 21); it relies on chemical mediators and cells to remove the offending agent and permit healing. Cardinal signs include: heat, redness, swelling, pain, and loss of function. Importantly, inflammation does NOT always equate with infection!

Figure 21 The inflammatory response.



The acquired immune response

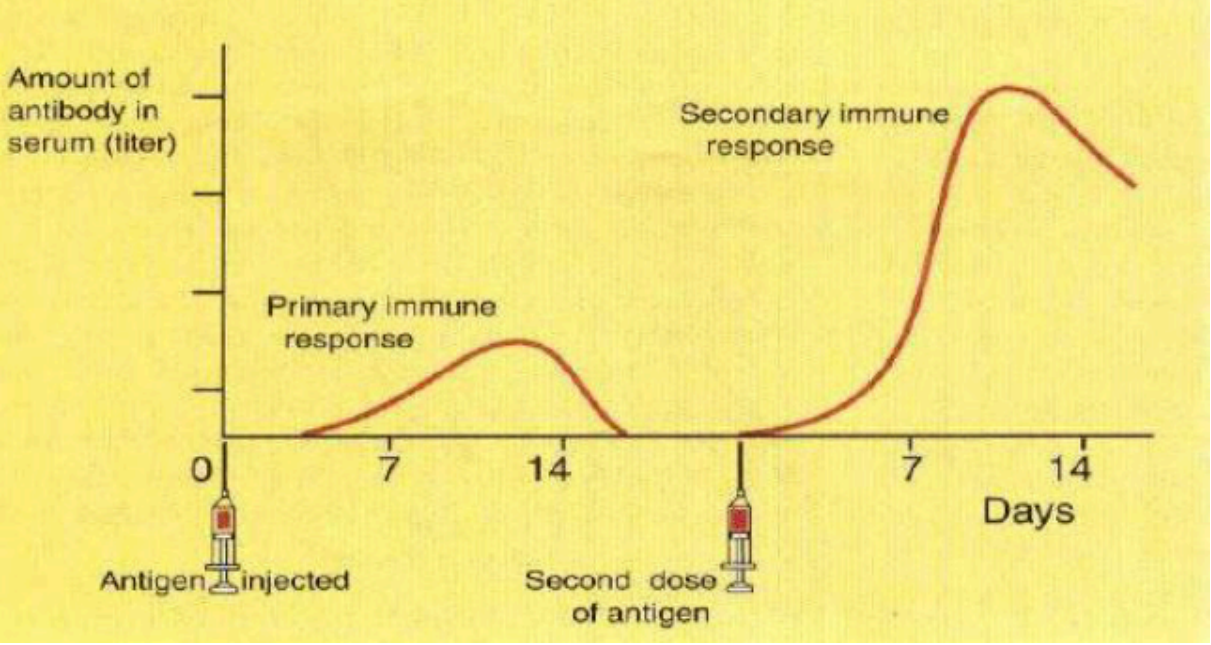
The acquired immune response is specific to the specific antigen or infectious agent. It requires exposure of the host's immune system to develop effective defense, which takes time. It is the basis for vaccination and many diagnostic tests. There are two arms of the acquired immune response – humoral (antibody-mediated) and cell-mediated.

1. Humoral acquired immune response

In a humoral response, proteins (antibodies) produced by B lymphocytes are distributed in serum and tissue to bind foreign material (antigen) and neutralise or promote removal. Each individual host has a few genetically programmed cells (both B and T lymphocytes) that will only respond to specific bacteria, viruses and foreign material (antigens). The body produces many differently programmed lymphocytes that can respond. When the individually programmed lymphocytes encounter the specific antigen, it produces clones that multiply and become effector cells as well as memory cells. The memory cells are able to more rapidly expand to cause an enhanced response upon subsequent exposure.

The presence and amount of specific antibodies measure humoral immune responses; when measured in serum this is called a "titer". Antibody titers increase after exposure and eventually wane over time. Antibody titers provide information about exposure (serological tests) and may correlate with the level of protection (Figure 22). Humoral immune responses are most effective against extracellular antigens, such as bacteria and viruses.

Figure 22 Measurement of humoral immune response.



2. Cell-mediated immune response

The cell-mediated immune response is mediated by T lymphocytes that recognise and respond to abnormal cells or intracellular pathogens, such as, virus-infected cells, tumour cells and transplanted tissue. Measurement of cell-mediated immune responses is typically more difficult. Usually performed using specific functional tests, which measure production of cytokines (such as gamma interferon) or in vivo response (such as the tuberculin skin test). These detect a "memory" response in animals that have been previously or are currently exposed to the specific antigen.

Development of the Fetal/Neonatal Immune System in Mammals

Development of the feral/neonatal immune system on mammals follows a consistent pattern in most species. Many species have well developed immune systems at birth. However, certain infections can affect development of the immune system in utero (e.g., bovine viral diarrhea infection). The susceptibility of neonates to infection is due to the naïve state of the immune system and lag time required for an effective response. Therefore, immediate protection during this period must come from the dam.

The mechanism of transfer of immunity depends on the species. In primates, rodents, and carnivores, there is a transfer of immune cells and antibodies from the dam across the placenta to the fetus, which provides protection at birth. However, swine, equids, and ruminants rely primarily on acquiring protective antibodies through the colostrum/milk obtained by nursing after birth. The period when the neonate can effectively absorb these is only for about 24 hours after birth – therefore, they need to nurse! Within days, the barriers in the gastrointestinal (GI) tract will start to exclude these large proteins and cells. However, the antibodies and cells in milk will continue to provide local protection in the GI tract. Neonates may be at greater risk if their dam has not been exposed, or vaccinated or has low-quality colostrum. The duration of passive protection from maternal antibodies depends on the amount absorbed, which wanes over time, while the neonate's own immune system starts to develop.

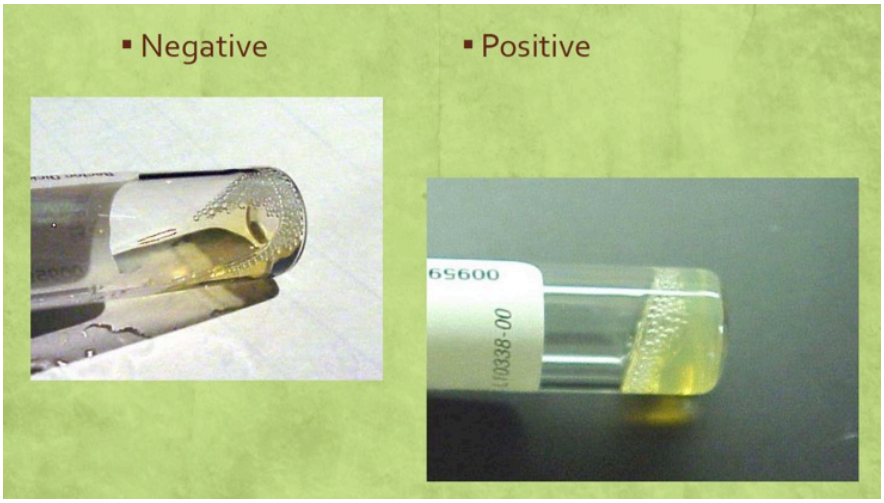
Failure of passive transfer (FPT) is the most common immunodeficiency syndrome in all species. It is not usually recognised clinically in primates and carnivores although the neonate may be more susceptible to GI disease. In herbivores, FPT can result in a "poor doer", navel ill, joint ill, diarrhea, weakness, respiratory disease and generalised infection, which can be fatal. Although frequency of FPT in wildlife is unknown, it is estimated to be around 15%.

FPT should be suspected if the calf is unable to nurse, is weak or premature, it is a first time dam, or nursing has not been observed. The calf should be examined and blood tests performed at 24 hours of age. However, there are few validated tests for wildlife species. Some that have been used include measurement of serum total protein, glutaraldehyde coagulation, zinc sulfate precipitation, and serum protein electrophoresis (Figure 23).

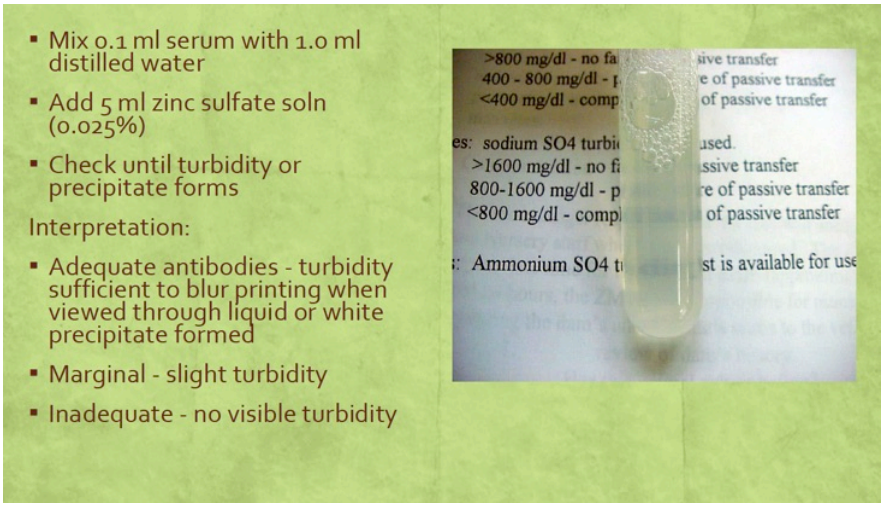
If FPT is diagnosed, treatment should be considered based on age, value, prognosis, species, and management. The best results are obtained if FPT is treated before clinical signs develop. Therapeutic decisions include the type of produce (e.g., frozen colostrum, colostrum replacer, or plasma), route of administration (i.e., intravenous versus oral), and the volume or concentration required. If less than 12-24 hours of age, use oral colostrum or milk replacer with high antibody concentration. Plasma can also be administered orally. Approximately 10-15% body weight should be received over a 24-hour period. If older than 24 hours, consider parenteral plasma and oral colostrum. Plasma can be obtained from another herdmate or purchased (i.e., equine plasma) but risks such as disease transmission, transfusion reaction, expense, time, and risk to donor should be considered. Ideally, plasma is administered thorough a jugular catheter at the rate of approximately 20 ml/kg/hour, while monitoring for signs of reaction. However, prevention is the key to minimising morbidity and mortality associated with FPT but ensuring that the dam is properly vaccinated, maintaining general good health and nutrition of the dam, and minimises the exposure to pathogens in the environment.

Figure 23 Tests for FPT.

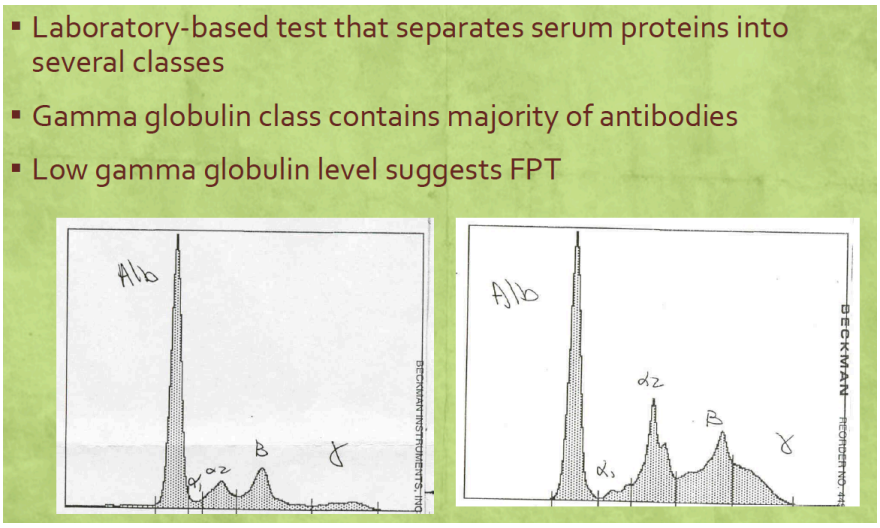
a) Glutaraldehyde coagulation



b) Zinc sulfate turbidity



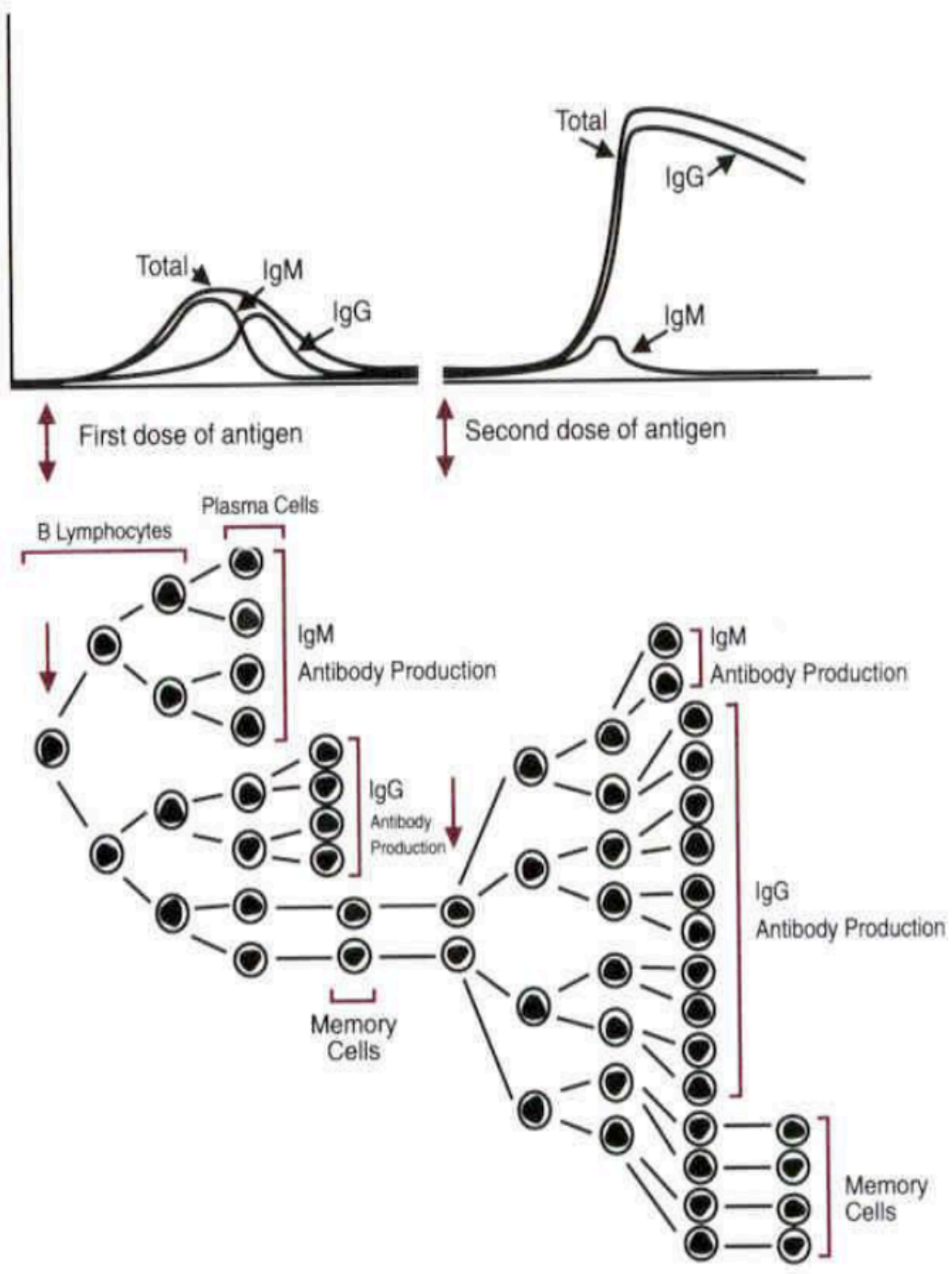
c) Serum protein electrophoresis



Principles of Vaccination

Vaccination stimulates the host's protective immune response – ideally mimicking natural exposure and memory response. Vaccination schedules are based on the principle of amnesis (memory). The first vaccine introduces the antigen to stimulate clones of programmed cells to produce antibody, effector and memory cells. The vaccine booster then further amplifies the immune response (Figure 24). Periodic exposure is required to maintain this amplified level of antibodies and antigen-specific immune cells. Immunity is the result of adequate numbers of cells and antibody titer to result in protection of the host and elimination of infection.

Figure 24 Immune response to vaccination.



Vaccination schedules for commercially available products are based on evidence that the vaccine induces a protection immune response in the designated species. Guidelines for use in non-labeled species are extrapolated from domestic animals. There are limited studies on efficacy and safety in wildlife species, and the ability to stimulate a protective immune response is generally unknown.

Vaccination of wildlife species requires the selection of the vaccine product, dose, route, and frequency of administration. However there are potential risks or adverse effects associated with vaccination including trauma associated with administration, especially when using darts, hypersensitivity reactions, vaccine-associated abscesses, or tumors. The risks should be carefully balanced with the benefit of vaccination. Therefore vaccination should be based on principles of efficacy and safety as well as the risk of disease.

Immunodiagnostic Tests

Immunological diagnostic tests are based on detecting a specific immune response to a pathogen in the host. These responses may take weeks, months or even years to develop. It is also a dynamic system and changes in immune response occur with progression of infection and development of disease, which affects test results. Test results are classified as negative or positive based on predetermined cutoff values. The measurement of most tests usually occurs along a continuum. However, the results will vary with method, laboratory, or even between people reading the test. Also individual host variation may lead to some results being incorrectly classified.

Serological assays detect specific antibodies in serum, which measure the humoral immune response. There are also serological tests that detect antigens so it is important to clarify what is being measured. The result is usually read as a titer; the higher the concentration of antibodies in the sample, the higher the dilution (titer); for example, a sample with a titer of 1:800 will have more antibodies than a sample with a titer of 1:100. There are different techniques for detecting antibodies; some of the most common are enzyme-linked immunosorbent assay (ELISA), viral neutralisation (VN), agglutination or precipitation assays, and complement fixation (CF). Since the titer may change depending on type of technique, it is important to be familiar with the test being performed and ask the laboratory how they interpret positive and negative results.

Serological tests do not necessarily detect active infection; the test detects antibodies to that agent. In order to determine if an infection has occurred, paired serum samples should be collected approximately 2-4 weeks apart. If the second sample has a titer increased by 4 times or greater, it is indicative that the response was due to a recent exposure.

Assays to detect cell-mediated immune responses can be performed in the animal (in vivo) or using specialised laboratories. The tuberculin skin test is an example of an in vivo test. Generally cell-mediated immunoassays are less commonly used since they require that a fresh blood sample reach the laboratory within a day. Also species-specific reagents are often required.

Immunoassays that detect the organism are also available. The result detects the presence of the pathogen in the sample, and does not rely on the animal's immune response. However, choice of sample and handling are important.

Immunodiagnostic assays should be used strategically. This requires an understanding of the disease, knowledge of immunology of the species, determining what the specific diagnostic test measures, and information regarding the individual's history, health and management (including vaccination) in order to interpret the test results.

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