Rabies in kudu and eland #2:
Herd immunity in rabies and COVID-19

The COVID-19 pandemic has a profound effect on all of us. Not a day goes past without people discussing concepts like infection rates, immunity, vaccination, herd immunity, social distancing etc. Since winter (after the leaves have dropped from trees) is also the optimal time of the year to vaccinate kudus and eland against rabies. It is a good time to discuss some of the above concepts and explain the similarities and vast differences between rabies transmission and prevention in our wildlife population compared to COVID-19 management in people. If you want to know more about rabies in kudus/eland, check our articles here.

Herd immunity

Highly contagious disease outbreaks (epi- or pandemics) typically end in one of two ways:

- Cases are tracked and isolated (in animal populations culling rather than isolation is applied), or
- A population achieves herd immunity, often with the help of a vaccine.

In herd (population) immunity members of a population benefit of indirect protection from an infectious disease (usually a virus) after a large percentage of that population has become immune to that disease.

Immunity can be achieved either by vaccinating people/animals against that disease (e.g. rabies or COVID-19) or, after a patient has been exposed to, and recovered from an infection and is now immune against that disease. The greater the percentage of immune individuals in a population, the more effective the physical shield they "build" around non-immune individuals will be, thus achieving the state of herd immunity. This will slow and eventually stop the spread of infection.

The level of population immunity needed to achieve herd immunity largely depends on the virus involved (infectivity, mortality rate etc.), the population (population density, susceptibility etc.) and on the nature of immunity achieved, but a figure between 60-90% is generally quoted.

- The more contagious the virus, the higher the threshold for herd immunity.
- The risk of transmission within a population depends on population density – the closer the contact between members of a population, the quicker and more effective the spread of the disease.
- The effectiveness of immunity against a virus is important. The less effective or short-lived the immunity is, the more difficult it will be to achieve herd immunity.

Individuals can become immune by recovering from an infection or through vaccination. However, not all individuals within a population will pick up immunity (e.g. sick and/or too young to be vaccinated and in wildlife, some animals will not be spotted and thus "skip" being vaccinated). Herd immunity is essential to protect this group of individuals. Once a certain threshold (minimum 60-70% of the population immune) has been reached, a disease will gradually be eliminated from a population.

Herd immunity through mass vaccination has become a common and successful technique used to prevent the spread of many infectious diseases in people (e.g. polio, measles etc.). The recent increase in opposition to vaccination amongst some people, the so-called "anti-vaxers" has allowed previously "eradicated" diseases (polio and measles as prime examples) to return to communities with inadequate vaccination rates. Figure 1 shows the concept of herd immunity.

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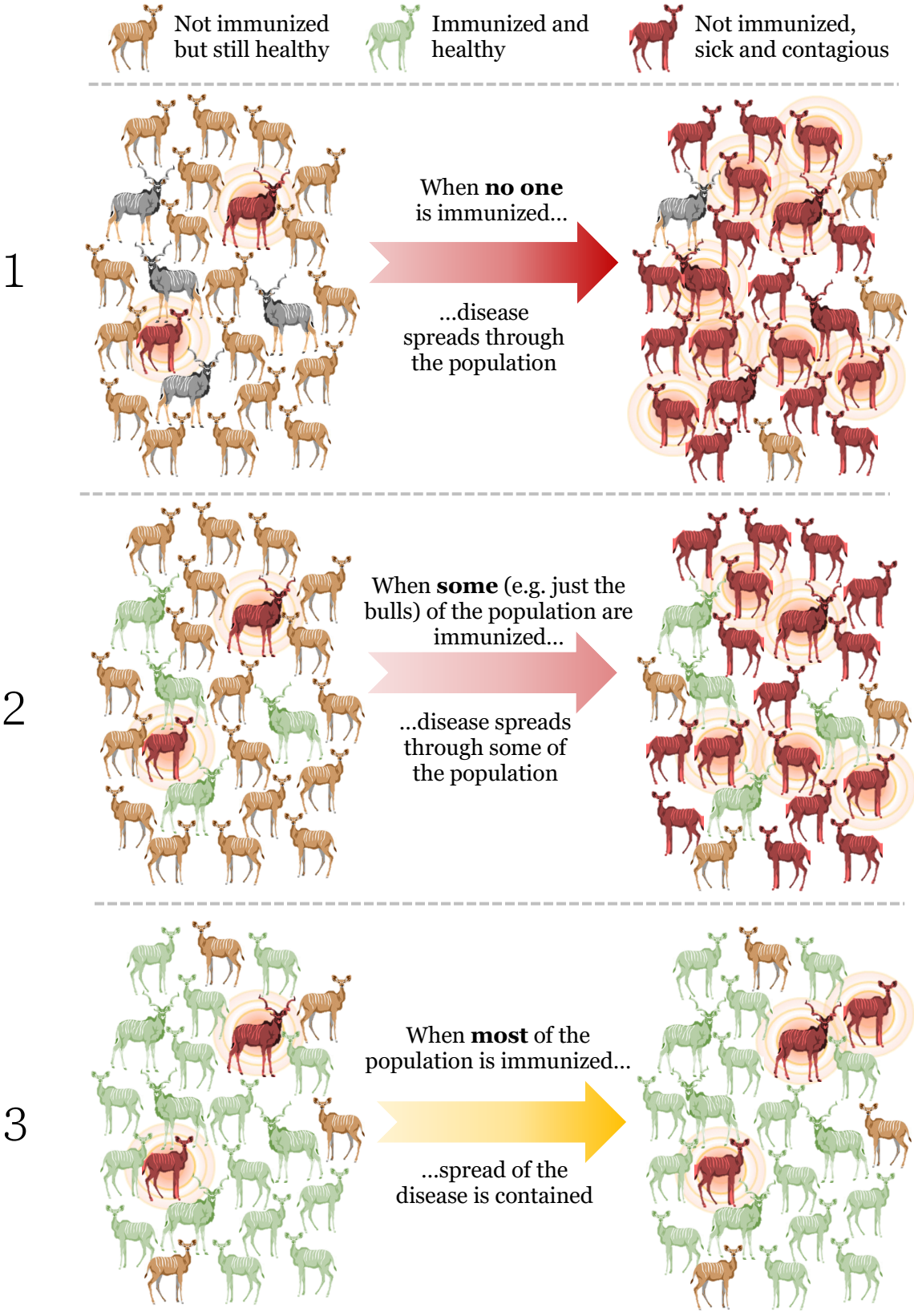

Figure 1

1 shows a disease outbreak in a population. Just a few animals are infected (red), and the rest are healthy but not immunized (normal colours). The disease will then spread freely through the entire population.

2 When a few animals are vaccinated (immunized, shown in green), a disease can still spread quickly to unvaccinated animals.

3 When most animals in the population are vaccinated, they limit the effectiveness of a disease. In other words, the disease is prevented from spreading throughout the entire population. The ability of immunized animals (or people) to protect others is what we call 'herd immunity'.

In the first 2 examples, most kudus get rabies from the 2 infected kudus. In third example, only 1 additional kudu suffers from rabies. Most of the others are immune, and others are protected as they don't come into close contact with the infected animals.

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Rabies compared to COVID-19

In Table 1 the main differentiating features between rabies and COVID-19 are listed.

Table 1 Basic features of rabies compared to COVID-19

Disease characteristics	Rabies	COVID-19
Virus?	Yes	Yes
Infectivity	High but needs very close direct contact	Very high and can be transmitted indirectly (surface contamination)
Mortality rate	Nearly 100% of the infected	Less than 1% of infected
Vaccine availability	Yes, very good vaccine	None yet
Does immunity develop After natural infection? After vaccination?	 Few survivors, suspect good immunity Very good & long lasting	 Unknown, maybe not long lasting Unknown, maybe not long lasting
Herd immunity achieved at	60-70% population immunity	90%+ population immunity
Herd immunity possible through Natural infection? Vaccination?	 Not feasible, high mortality % Yes, very good	 After 90% of population infected ? Time will tell…
Does "social distancing" help?	Yes, disease stops at low population density	Yes, vitally important management tool

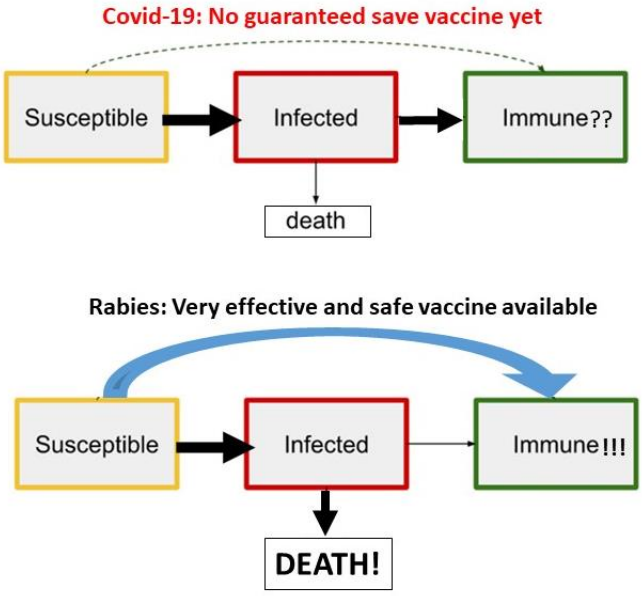

Figure 2 Comparing the course of disease of COVID-19 vs. rabies. Currently, herd immunity in COVID-19 can only be reached through natural infection of the masses. In contrast to rabies, a fatal disease, where herd immunity can only be reached by vaccination. © U. Tubbesing

From a disease management and prevention point of view it is especially important to notice that, compared to rabies, COVID-19 has a low mortality rate. Achieving a state of herd immunity following natural infection is thus a near unobtainable goal with rabies, but **theoretically possible** with COVID-19 (Figure 2). Why only theoretically possible? In spite of the commonly circulating "information" quoting the insignificance of COVID-19 in terms of previous pandemics, the truth is quite sobering – consider this:

1) Our current medical capabilities are far better than 100 years ago. Would the mortality rate with the Spanish flu been as high today?
2) We are only at the beginning of the COVID-19 pandemic and can't compare total mortality with historic statistics. Worldwide so far "only" 21 million people (out of 7.8 billion) have been confirmed infected with "only" 800 000 (4% of infected) deaths. Thus, until now only 0.3% of the world population has been infected (Source: WHO). Without the benefit of an effective vaccine, it is estimated that around 90% of the world population would become infected before the benefit of herd immunity would step in. Under such a worst-case scenario, the final COVID-19 mortality rate would be somewhere in the 31 million mark. Hardly insignificant in our times of sophisticated medicine!

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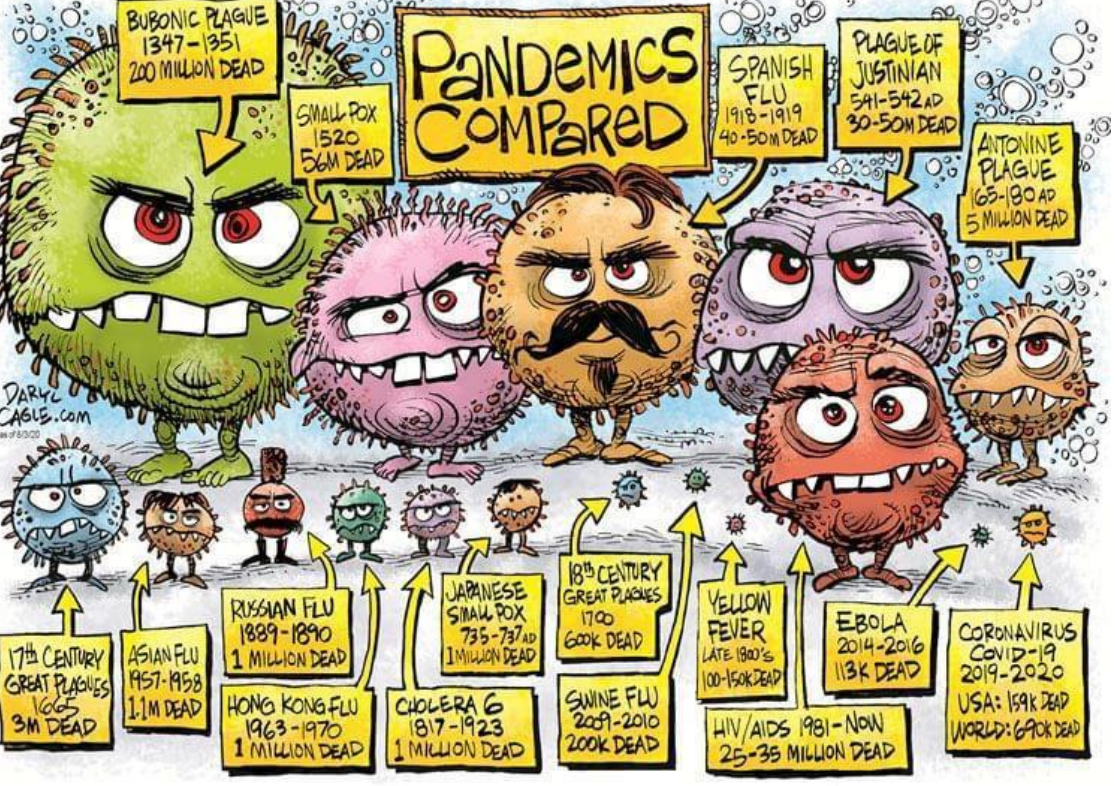

Figure 3 Pandemics compared. © Daryl Cagle illustration / caglecartoons.com

Unless a safe and effective vaccine is developed soon, the world population will experience a lot of hardship before we will enjoy the benefit of herd immunity.

With rabies we have the huge benefit of a safe and highly efficient vaccine that provides man and animal with relatively long lasting immunity. Since the average antelope herd grows by 25-30% annually, it is advisable to vaccinate a farm's kudu and/or rabies population at least every 2 years (see the second article in this series).

Needless to say, a disease outbreak can be totally prevented by prophylactic (preventative) vaccination (if a vaccine is available). In the absence of an effective vaccine the disease will spread unchecked until herd immunity is reached and/or the population has been decimated to such an extent that a "social distancing" effect comes into play (Figure 4). Delaying vaccination until an actual disease outbreak occurs will only be partially effective since a certain percentage of the population would have already died and more animals would be sick and spreading the disease in the 7-21 days it takes before an animal develops proper immunity following vaccination (see next article).

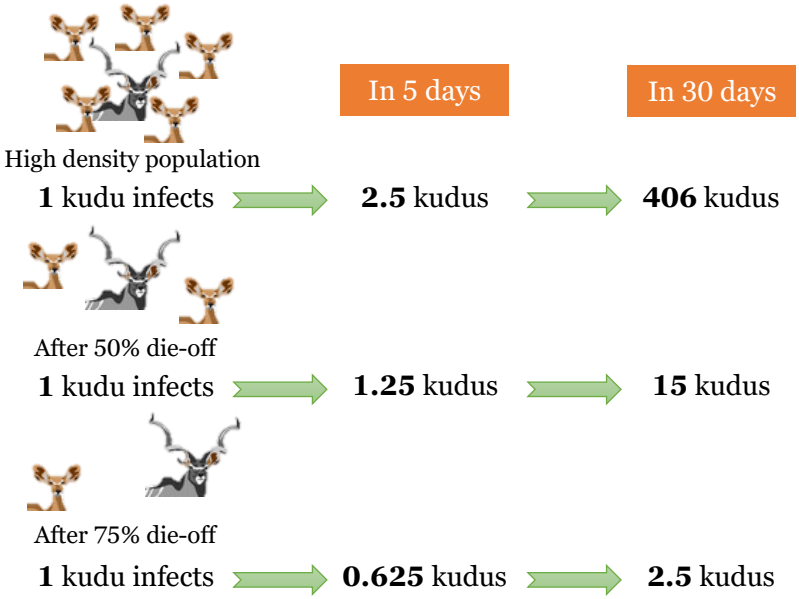

Figure 4 Indirect 'social distancing' effect coming into play once a disease has diminished the herd numbers on a farm © U. Tubbesing

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Social distancing

How does social distancing help to curb the spread of an infection? Let us once again take COVID-19 as example – here we have seen vast differences in disease spread between different countries and this was mostly due to the timing and degree of enforcement of social distancing regulations.

Consider the following example: Starting off with one COVID-19 infected person, the virus spreads and the number of cases doubles every four days. 36 days into the outbreak, countries A, B and C all have 512 cases!

- Country A **now** implements social distancing measures that reduces the doubling time from four days up to eight days. On day 60 of the outbreak this country has 4,096 cases.
- Country B implements the same social distancing measures as country A but only on **day 44** (8 days later, once it has 2,000 infected people). By day 60 country B will have around 8,200 cases.
- Country C **doesn't do anything** and lets the virus spread unchecked. 60 days into the outbreak, this country is dealing with more than 30,000 cases.

This example clearly illustrates both the impact social distancing has on the rate of spread of disease within a population and how important early action is to achieve this goal.

Conclusion

Considering the importance of kudus and eland as a game ranch species in Namibia, it should now be clear that herd vaccination against rabies is the only realistic way in which herd immunity against this potentially devastating disease can be reached. In the following article 'Rabies in kudu and eland #3: How vaccination leads to immunity' we explain how immunity works and why it is important to do follow-up vaccinations both against rabies as well as other important diseases. Click here to read and download this article.

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