Mating and the Birthing Season –

Can our game adjust their reproductive strategies?

Reproduction is one of the most fundamental processes in the animal kingdom, and ensures the survival and continuation of a species. However, the timing and success of mating, pregnancy, and birth are deeply influenced by environmental factors, species-specific adaptations, and even survival mechanisms triggered by adverse events such as drought.

In southern Africa, seasonal shifts shape wildlife breeding patterns. It seems that breeding and birthing periods among game species are remarkably synchronized with environmental conditions. But what happens during extreme droughts? Some observations suggest unexpected shifts in birthing seasons, raising important questions about the adaptability of these species. Could mechanisms such as embryonic diapause, a phenomenon known in some mammals, also play a role in African game species? In this article we dive into the complex balance of animal physiology (how the body functions), how wildlife responds to environmental challenges, and how they use unique reproductive strategies to maintain and grow their populations.

Introduction to reproduction physiology and terminology

Pregnancies in mammals, from fertilization to birth, are broadly divided into three stages which are each marked by distinct developmental milestones[1]:

- **Germinal stage (weeks 1-2):** This first stage begins with fertilization (when sperm and an egg join), followed by rapid cell division of the fertilised egg, forming a blastocyst. A blastocyst is sort of a hollow little sphere made up of two main parts:
  1. A group of cells that will eventually form the baby.
  2. A layer of cells that will help create the placenta (the organ that nourishes the baby during pregnancy).

  This stage ends when the blastocyst implants itself in the uterus lining (endometrium).
- **Embryonic stage (weeks 3-8):** The blastocyst develops into an embryo. By the end of this stage, basic body structures, including limbs, eyes, and internal organs, are formed. At this stage the embryo is still very small.

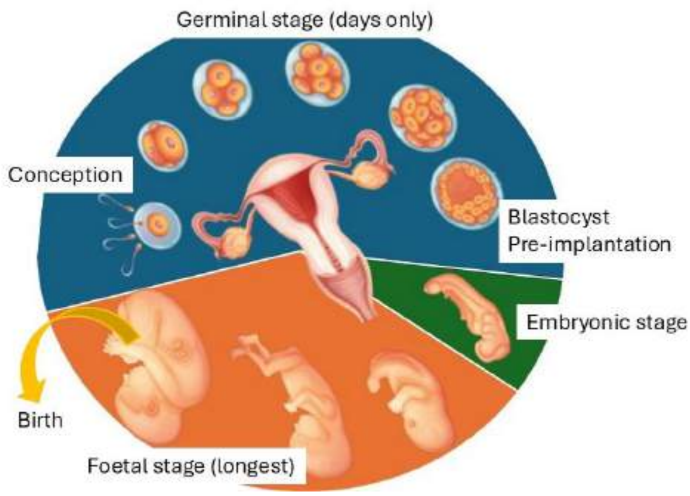

Figure 1 The developmental stages from conception till birth © Modified image from PNG Tree by U. Tubbesing.

[1] Timelines given here are for a human pregnancy. These timelines will vary between species depending on the length of pregnancy.

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- **Foetal stage (week 9 until birth):** This is the longest stage of prenatal development; the embryo transforms into a foetus, and the organs, tissues, and body grow. This period marks important developments in the nervous and genital systems. Under ideal nutritional conditions and health of the dam, a healthy calf or lamb is born and develops into a mature animal.

Reproduction is not just dictated by biological processes. Environmental conditions also play an important role. When food resources are scare due to drought, reproductive success can be severely impacted. Starvation stress is one of the main reasons why animals go into anoestrus (a state where females do not come in heat), resulting in *poor conception rates*. Even females in poor condition that did conceive and became pregnant, may resorb or abort the unborn foetus, and thus not carry the pregnancy to full-term. These are well-known survival mechanisms resulting in low calving/lambing percentages, but gives improved survival chances for the adult females, who can re-enter the reproductive cycle once environmental conditions have improved. Figure 2 shows the various reproductive stages and shows how nutritional stress may disrupt these.

Conception rates refer to the percentage of females in a population that successfully become pregnant after mating. A high conception rate means many females conceived, while a low rate indicates fewer pregnancies, often due to factors like poor nutrition or environmental stress.

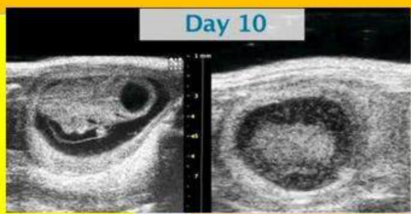
DIFFERENT REPRODUCTIVE STAGES OF MAMMALS					
		NORMAL PREGNANCY			BIRTH & GROWTH TO WEANING
OPTIMAL NUTRITION	Oestrus & mating	Germinal stage (days) (Fertilisation-blastocyst-implantation)	Embryonic stage (weeks) (early organ development)	Foetal stage (months) Final organ development and growth till birth)	NORMAL
STARVATION	Anoestrus	No pregnancy develops and female starts next oestrus cycle once nutrition improves			NONE
	Oestrus & mating BUT	**Embryonic resorption** - Happens in very early pregnancy. No embryonic tissue is expelled by female. Protective mechanism to improve chances of survival of female			NONE
	Oestrus & mating BUT		**Abortion** - happens later in gestation – foetus and foetal membranes expelled		Weak calf/lamb dying soon after birth

Figure 2 The potential influence of a starvation stress on reproduction in mammals © U. Tubbesing

Lambs or calves born during severe droughts usually have poor survival chances. Youngsters born under these conditions tend to be very weak and often die soon after birth. In species hiding their offspring for the first days to weeks (e.g. springbuck, impala, warthog), we will mostly likely be unaware of them ever having been born. Under these conditions the typical *lamb flush* would not be observed at any time.

A 'lamb flush' refers to a period when many lambs are born within a short timeframe, typically in species that synchronize their birthing season.

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In animal reproduction we use specific terms related to population growth and adaptation to environmental conditions. Terms commonly used in animal reproduction are:

> **Fecundity** is the ability of an individual to produce an abundance of offspring. This is most strongly positively linked with good rainfall before conception and goes through to early gestation.
>
> **Fertility** measures the actual number of offspring produced by an individual or population (this is often expressed as calf- or lamb percentage).
>
> **Recruitment rates** refer to the number of new individuals added to a population. This can be the result of successful reproduction, immigration (outside animals joining a herd), or dispersal of members of a herd (usually young bulls). Recruitment rates often correlate with weaning percentages, which reflect the survival of young animals beyond their most vulnerable early stages.

Normal breeding, calving and gestation periods on our plains game

Mammalian females, especially in their last trimester (third) of pregnancy and in the weeks following birth, have very high nutritional demands. These high nutritional demands ensure their own survival, while also supporting the rapid growth and development of the near full-term foetus. Once the offspring is born, lactation further increases the mother's nutritional requirements. This demand persists throughout the first weeks of the newborn's life.

This is also the period in which the pregnant female, and later her offspring, are most vulnerable to adverse/harsh environmental conditions. Most antelope species (as well as warthogs) thus give birth at a time when environmental conditions are optimal, maximising survival rates. In southern Africa this tends to be during the spring and summer months (August to February), when food and water availability are at their peak.

Many species have a rather narrow, species-specific period (often days to 2-3 weeks) within which virtually all the calves or lambs are born. The more vulnerable a species is (e.g. impala, springbuck, warthog), the shorter and seemingly more synchronised the birthing period is. This so-called "**lamb flush**" overwhelms predator take-off and thus reduces the risk of lamb/calf losses due to predation, and improving survival rates.

The 'lamb flush' likely helps reduce the time when newborns are most at risk from predators, especially in the first few days after birth. This increases their chances of survival.

As a rule of thumb, species with greater body mass as well as those species where the offspring must be mobile and be able to keep up with the movement of the mother (herd) very soon after birth, often have longer pregnancies to allow for sufficient foetal development.

Species where the offspring is initially more vulnerable and not able to fend for themselves (born with closed eyes, taking a long time before becoming mobile, e.g. warthog and mostly carnivores as well as rodents), birth typically takes place in a den.

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The duration of pregnancy in most mammals is species-specific. By working backwards from the calving season, we can calculate when breeding (mating) took place. Breeding or mating season is when the females of a species come into heat (oestrus) and thus allow mating.

Figure 3 Impala 'kindergarten'. After birth, impala ewes often leave their lamb hidden in dense vegetation for a few days. Once the lamb is strong enough, the lambs join together in a group. A few adult ewes act like a 'babysitter'. This strategy helps to reduce the risk of predation (more eyes watching), and it allows the lambs to interact and learn from each other. © M. Bijsterbosch

Table 1 The mating and birthing season of some common southern African plains game species compared to the average length of gestation and body mass.

Species	Body weight (kg)	Gestation (days)	Gestation (months)	Lambing/calving season	Mating season
Warthog	45-100	170	5.7	Nov	June
Springbuck	30-60	170	5.7	Oct- Nov	April-July
Impala	45-65	196	6.5	Nov-Jan	May
Blesbok	60-70	240	7.5	Nov-Dec- Jan	April-June
Red Hartebeest	105-180	240	8	Oct-Nov	Feb-March
Oryx	210-240	264	9	Aug-Sept	Nov-Dec
Blue Wildebeest	170-250	250	8.3	Mid Nov-end Dec	March-April
Waterbuck	160-270	280	8.3	Aug-Sept	Jan-Feb
Eland	400-900	280	9.3	November	February

Table 1 gives an overview of the mating and breeding season of some of the common game in southern Africa. These reproductive patterns are well accepted general rules of nature. However, during and following times of extreme drought (as experienced in Namibia in 2019 and again in 2024), game farmers and nature lovers observed a definite exception to this rule!

We found that the birthing season of almost all common plains game species was delayed by between 2-4 months. The onset of birthing at the end of 2024 and beginning of 2025 varied between regions in Namibia, but generally coincided with a time after at least some rain had fallen and the veld started greening up. We also noticed region dependant variations in birthing, for example Springbuck in central Namibia lambing in late January vs. those in the south-west of the country in early March. This once again was associated with the onset of rain in the specific regions.

Although unusual, this shift was a good since it supported survival rates, ensuring that lambs and calves were born at a time when resources were more favourable (large parts of Namibia only started to receive good rains towards the middle of March).

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What factors influence the breeding and calving season in our game species?

We all know that wild animals have remarkedly timed reproductive cycles. But how is it possible that the oestrus cycle (females being in heat) in our wild animals is timed in such a way that birthing is taking place during the optimal season? This is the result of natural selection over hundreds of generations, favouring the survival of those females and their offspring, that calved/lambed during these optimal times. Scientifically proven triggers that stimulate breeding in animals are discussed below.

Photoperiodism and breeding seasons

The traditional explanation to what influences breeding and calving/lambing seasons, is based on *photoperiodism*. This is a biologic phenomenon which enables an animal to regulate its physiology and behaviour in response to a change in *daylength* (the photoperiod), the most reliable indicator of the time of year (season).

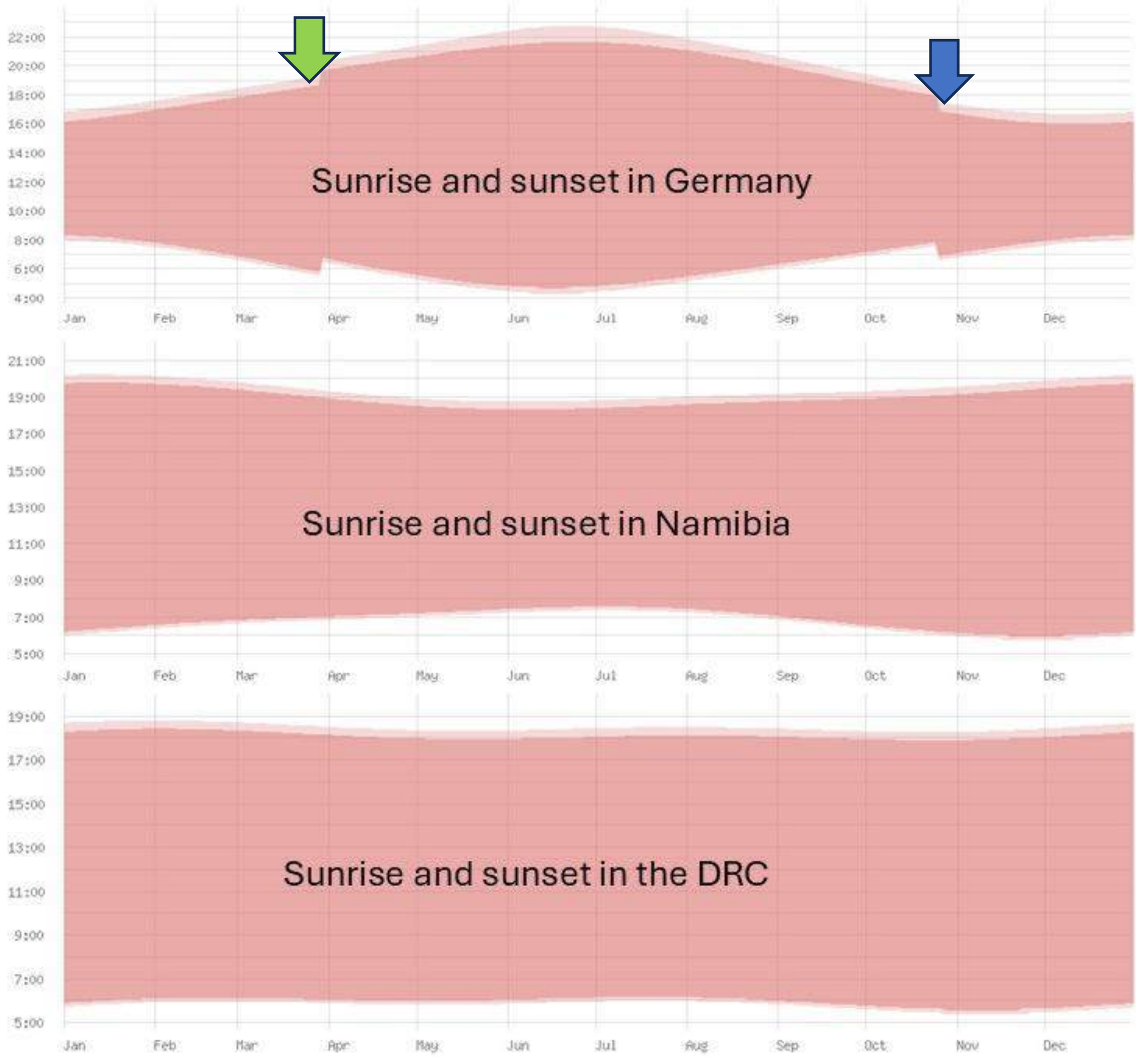

Figure 4 The difference in daylight hours between high latitude (Germany) to low latitude (Namibia and DRC), demonstrating minimal to no variation in day length in the lower latitudes. Dark pink is the sunshine period, while light pink is the twilight phase. Modified from [WorldData]

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According to the photoperiodism theory, the reproductive cycle of mammals is influenced by seasonal changes in daylight. In this theory, we differentiate between:

- **Long day breeders** (green arrow in Figure 4) begin their reproductive cycle when days get longer (spring) and are in anoestrus (when no mating takes place) in autumn and winter. These are usually relatively large animals (e.g. horses and red deer) with a long gestation period. Some smaller species with short gestation periods also follow this pattern. This enables these species to have their offspring during the spring and summer months when food is most abundant.
- **Short day breeders** (blue arrow in Figure 4) begin their reproductive cycle in autumn or early winter, when the length of daylight shortens. These are usually medium sized animals like those discussed in this article, with gestation periods of about 6 to 9 months. This enables them to calf/lamb in spring or summer.

The photoperiodism theory seems very applicable to mammals living in high latitude areas, where seasonal daylength varies considerably and influences breeding period. By timing births in such a way that the mother can raise the calf/lamb when food is plentiful and the is climate optimal, species can maximize their reproductive success.

However, looking at Figure 4, we notice that the difference in day length is insignificant for Namibia, to non-existing in many parts of tropical Africa. It therefore seems unlikely that photoperiod is the main influencer of the breeding season in these regions.

The role of rainfall in breeding seasons

In many parts of Africa, especially in the tropical regions, the variation in day length is far less pronounced than in the higher latitudes. As a result, the photoperiodism theory (the process where animals adjust their reproductive cycles based on seasonal day light changes) is a less likely driver determining breeding seasons amongst African wildlife. Instead, research suggests that variation in *rainfall* in the months preceding mating have a greater influence on reproductive performance.

In a savanna habitat, seasonal variations in rainfall influences both the quality, and quantity of available food. Here, rainfall is the main driver for reproductive seasonality, influencing both the timing and synchrony of breeding.

Forage quality is typically best early in the raining season, after the first rains. The early and fine grasses are ideal for selective grazers. As the rainy season progresses, the forage quantity increases, benefitting non-selective bulk grazers. At the same time, the nutritional forage quality declines.

When looking at Table 1, we notice that both breeding and birthing seasons are strategically timed to coincide with periods of optimal food availability. Fecundity and recruitment rates tend to be best in years with average rainfall for an area. Extreme conditions, such as too little or excessive high rainfall, negatively affect reproductive success.

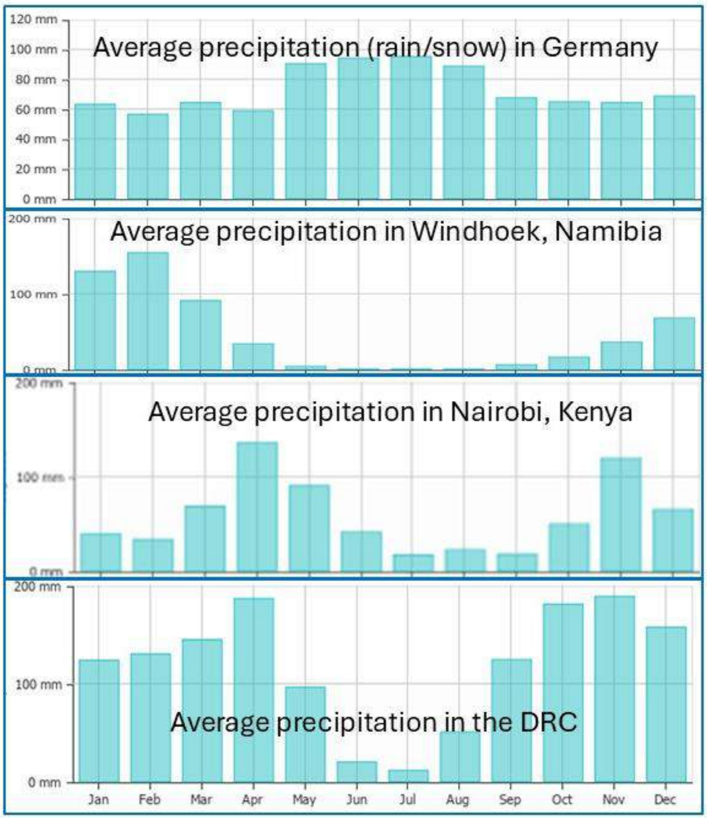

Figure 5 Average precipitation compared in Germany, Namibia, Kenya and the DRC.

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The availability of food before breeding, during pregnancy and after birthing plays a crucial role in reproductive success, and thus offspring survival. Some profound effects are:

- **Maternal health and fertility:** The body condition of females, and whether they will sufficiently recover from the previous pregnancy and lactation to enable them to come on heat (oestrus) and conceive.
- **Foetal growth and viability**: Starvation of the dam may well result in resorption or abortion of the foetus, which improves her chances of survival, and allowing her to re-enter the reproductive cycle once food availability improves.
- **Milk production and newborn care:** The ability of the dam to produce sufficient milk, and to be able to look after the newborn ensures its growth and survival.
- **Offspring survival and growth rates**: Animals born in times of plenty are likely to reach sexual maturity at an earlier stage than those born during drought years.
- **Annual shifts in birth peaks:** The timing of births is often linked to the previous rainy season, and birth peaks can shift based on environmental conditions.

Mating seasons in seasonally breeding animals

The timing of the mating season in seasonally breeding animals can be largely subdivided into three groups, which tend to be closely associated with latitude:

- **High-latitude regions:** The high latitude regions where weather and precipitation are relatively predictable, many animal species have a fixed optimal mating season which is determined by photoperiodism. Animals in these regions are subdivided into short-day breeders (who mate as daylight decreases) and long-day breeders (who mate when daylight increases).
- **Tropical and sub-tropical regions:** These regions have minimal variation in day length and near year-round forage availability, so most species have a continuous optimal breeding season. Here, rainfall (and thus food availability) preceding the breeding season is the main factor determining the breeding season.
- **Arid regions:** Arid regions (deserts and semi-deserts) often have highly unpredictable rainfall patterns, and thus highly variable grazing conditions. This results in relatively unpredictable mating seasons. Species living in these areas often adapt to shifting environmental conditions, making their reproductive cycles less predictable.

We now know that the timing of births among African plains game is closely linked to environmental conditions, particularly rainfall and subsequent food availability. Table 2 on the next page shows the variation in birthing seasons across the tropics, sub-tropics and regions south of the Zambezi. By comparing these patterns, we can get an insight in how various game species adapt their birthing season to optimize their survival within their specific habitats.

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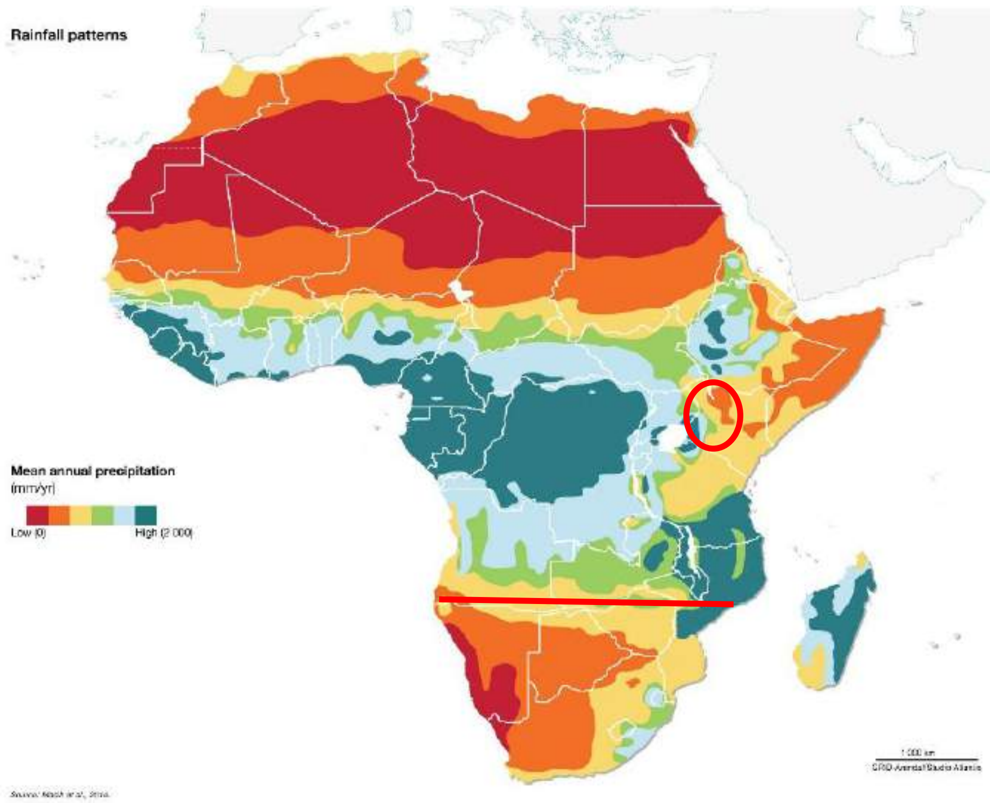
Table 2 Comparing the variation in birthing season relative to rainfall (food availability) for different African plains game species in the tropics, sub-tropics (Serengeti and Masai Mara with a minimum monthly average of 60 mm rain) and regions south of the Zambezi River. Species in yellow are 'followers', species in green are 'hiders".

SEASONALITY OF THE BIRTHING SEASON COMMON AFRICAN PLAINS GAME			
SPECIES	**TROPICS**	**SERENGETI/MASAI MARA**	**SOUTH OF ZAMBEZI RIVER**
Warthog	Year round	Seasonal narrow	Seasonal narrow early, Nov - Jan
Topi	Year round	Less synchronised birth	
Impala	Year round	Synchronous early raining season	Seasonal narrow early, Nov-Jan
Hartebeest	Year round	Less synchronised birth	Seasonal narrow, Oct-Dec
Sable	Year round	Year round	Seasonal narrow Jan-April SA/Bots/Nam
	Year round in zoos/intensive management - Food availability		Seasonal narrow June-Sept Zambia/Angola
Roan	As sable	As sable	Any time but distinct peak summer
Waterbuck	As sable	As sable	Any time but distinct peak summer
Wildebeest		Synchronised narrow (Jan-Mar)	Seasonal narrow, mid Nov - Dec

Figure 6 Map of average annual rainfall in (mm) in Africa. In relation to Table 2 above, the tropics are the dark blue section. The Serengeti and Masai Mara are shown in the red circle, the area south of the Zambezi is located under the red line. © GRID Arendal



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Question time!

Now here is a question we get asked frequently… **how do our plains game species, in times of extreme drought, manage to delay birthing until environmental conditions improve?** This is a very contentious issue with only a few feasible possibilities.

1. **The breeding season was delayed**

From the above discussion we know that times of severe nutritional stress are more likely to result in anoestrus (no mating taking place), as well as resorption and/or abortion or a high mortality rate amongst newborns.

In theory, females that fail to conceive during their usual breeding season could potentially enter heat later. However, given that many are already in poor condition due to the drought, it seems unlikely that they would be able to conceive much later and still produce strong, healthy offspring.

2. **The breeding season was as usual, but the pregnant animals simply delayed birth**

Let us take impalas as an example. They are synchronous breeders, meaning their mating season is timed to ensure that births coincide with the start of the summer wet season (November). This way, the females and their offspring have access to plenty of food and water.

At time of lambing, the females leave the herd and usually give birth around midday, when predators are least active. They then hide the lambs for a few days in dense bush to ensure the lamb is strong enough to keep up with the herd.

However, during times of drought, we often observe that impalas lamb later in the season than usual. Some people speculate that impalas can delay their births (in other words, prolong their pregnancy) to await environmental conditions more favourable for survival. However, animal reproductive experts disagree with this theory, and argue that the delayed lambing was a result of delayed mating.

Another opinion is that, during severe droughts, lambs are still born throughout November to January, but most of these weak lambs die unnoticed while they are hiding. Under these conditions the typical lamb flush would not be observed at any time. Some lambs that are born later, following the onset of rains, would have a better survival chance and thus give the impression of a synchronised late lambing season.

Starvation stress of the females is one of the main reasons why animals will not come in heat, resulting in poor conception rates. In addition, ewes in poor condition that did become pregnant may resorb or abort the unborn foetus, thus not carrying the lamb to full term. These well-known survival mechanisms will result in a low calving and lambing percentages but ensure that the adult female survives so she can reproduce at a later stage.

While these explanations provide strong insights into the mechanisms behind delayed births, one key observation challenges this theory: **a distinct lamb and calf flush was observed**, not only in impalas but also in **most grazers and warthogs**. However, recruitment rates following droughts tend to be **lower than usual**, supporting the idea that environmental stress significantly impacts reproductive success.

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3. Embryonic diapause

Living organisms have evolved to survive under various harsh environmental challenges like extremes in climates, as well as starvation stress. Embryonic diapause is a good example of such a reproductive survival strategy and is known to occur in over 130 mammalian species.

If animal species capable of embryonic diapause experience adverse reproductive conditions, cell division in the blastocyst slows down, or even ceases. This prevents the blastocyst from growing and implanting into the uterus. This pause in development delays the maturation of the embryo in the uterus until environmental conditions improve. This increases survival chances of both the dam and offspring. The roe deer is one species where embryonic diapause is known to exist (Figure 7). We will use this species to illustrate the process.

Figure 7 Roe deer with fawn in Great-Britain © Jules Cox

Roe deer pregnancies last about 10 months, however, for a significant portion of that time the development of the embryo is paused by embryonic diapause (Figure 8). The embryonic diapause begins within days of conception and is triggered by starvation induced deficiency of nutrients (certain amino acids as well as glucose and lactate) in the uterine fluid surrounding the embryo. Additionally hormonal imbalances, a potential consequence of starvation, contribute to the pause.

Amino acids are fundamental building blocks of proteins, and are essential for organ tissue formation, hormone production and other biological functions. The absence of these amino acids (due to starvation) strongly suggests that external environmental factors influence the onset and duration of embryonic diapause.

This nutrient deficiency in the uterine fluid of roe deer will, **for the next four to five months**, result in only minimal growth and development of the blastocyst. Once nutrient levels in the uterine fluid improves, and hormonal shifts (increasing levels of prolactin, progesterone and/or oestrogen) occur, the embryonic development re-activates. In some animals a change in day length (photoperiod) may also play a role.

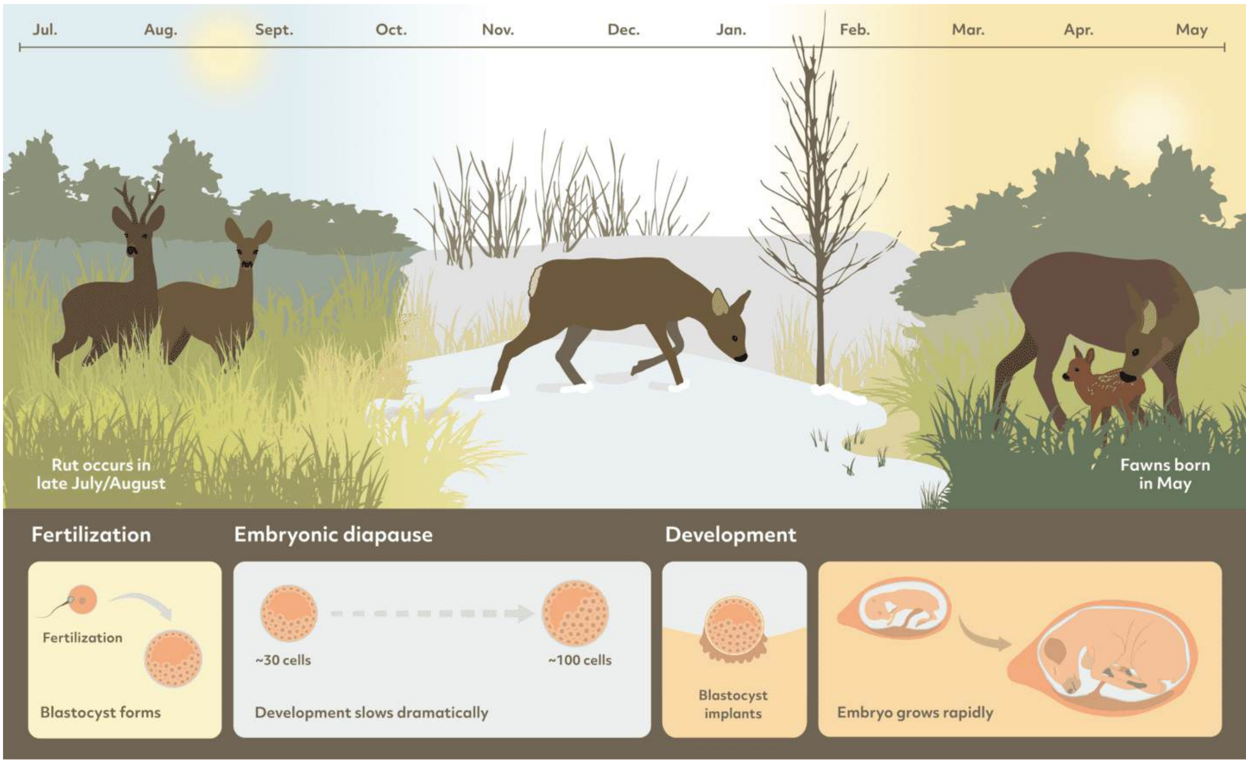

Figure 8 Roe deer have a 10-month pregnancy, but early in the process, the embryo's growth pauses due to embryonic diapause. This delay ensures that birth happens when conditions are best for survival. © Ask Nature

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The ability to pause the development of the embryo allows roe deer to mate and conceive during the normal rutting period in late summer. Birth can then be delayed until late spring, when food is abundant, and sufficient time exists for young fawns to grow before the cold winter starts.

Embryonic diapause has been experimentally induced by simulating starvation conditions in laboratory studies in species (e.g. mice) using sheep blastocysts or human stem cells, where neither sheep nor humans naturally exhibit embryonic diapause. This suggest that a hidden capacity for diapause likely exist in a much wider range of species than those currently known.

Could this be the solution to the riddle? Currently it is assumed that antelope are not able to go into embryonic diapause, and do not do so routinely. On the other hand, we could not find any research publications proving that antelope (and other African plains game) are NOT able to use embryonic diapause as a survival mechanism in times of severe nutritional stress.

Conclusion

The reproductive cycles of our southern African wildlife species are intricately linked to environmental conditions. While the traditional theory of photoperiodism (where the reproductive cycle of mammals is influenced by seasonal changes in daylight) may hold for animals in the higher latitudes, it seems that rainfall and the subsequently food availability are more significant drivers of the reproductive cycle for our southern African game.

After extreme droughts many farmers observed delays in birth, which may suggest that animals can adapt their reproductive cycle to enhance their survival. But whether this is due to a delay in the mating season, embryonic diapause or another biological response remains a question. What are your observations and ideas?

What is evident, is that nature always have extraordinary ways of ensuring survival! Further research into this topic is crucial, especially to improve our conservation strategies in the light of climate change.

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