

DISCUSSION OF SIZE AND MISPLACEMENT OF HEMISCROTA ON MAMMAL SPECIES: DESCRIPTIONS WITH PHOTOS

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In Montana and possibly throughout the Northern Hemisphere, a high prevalence of male mammals, especially those of ruminant and rodent species, now have developmental malformations of male genitalia. On a very high prevalence (approximately 70%) of our study animal, white-tailed deer, the left hemiscrota (half of a scrotum) and left testis are formed in a forward position, usually directly forward of the right hemiscrota and testis. On many males, the scrotum and/or the penis sheath is much shorter than what would be considered normal. A few males have only one hemiscrota or no scrotum at all formed on the external skin during fetal development. None of those birth defects were observed on a mammal prior to spring of 1995.



This photo shows a white-tailed deer scrotum with the left hemiscrota directly forward of the right hemiscrota. Both hemiscrota are completely visible in this view from the left side of the scrotum and are noticeably tipped toward the rear. Anterior is to the left.

The hemiscrota are formed in this position early in fetal development, thus the animal is born this way. This scrotal configuration has nothing to do with how or when an animal is killed, the animal's nutritional condition or how long it has been dead. This birth defect as well as the other reproductive malformations now common on male

mammals appear to be caused by hormone disrupting chemicals. Exposure to such toxins during development likely disrupts the signals from the epigenetic triggers, which direct normal development of the male reproductive organs. However, reproductive malformations can be and appear to be passed on to their progeny by males able to produce viable sperm. There is an extremely high prevalence of misaligned hemiscrota on several ruminant and rodent species and this condition has been documented on other mammals. Misaligned hemiscrota was not reported in the scientific literature until my colleagues and I published a study in 2002, reporting this and other reproductive malformations on white-tailed deer (Hoy, J.A., Hoy, R.D., Seba, D. & Kerstetter, T.H. 2002. Genital abnormalities in white-tailed deer (*Odocoileus virginianus*) in west-central Montana: Pesticide exposure as a possible cause. J Environ Biol 23: 189-197. PMID:12602857).

PHOTOS OF NORMAL GENITALIA TAKEN OF ACCIDENT OR HUNTER KILLED MALE WHITE-TAILED DEER CARCASSES OR PROSECTED FROM THE CARCASS.

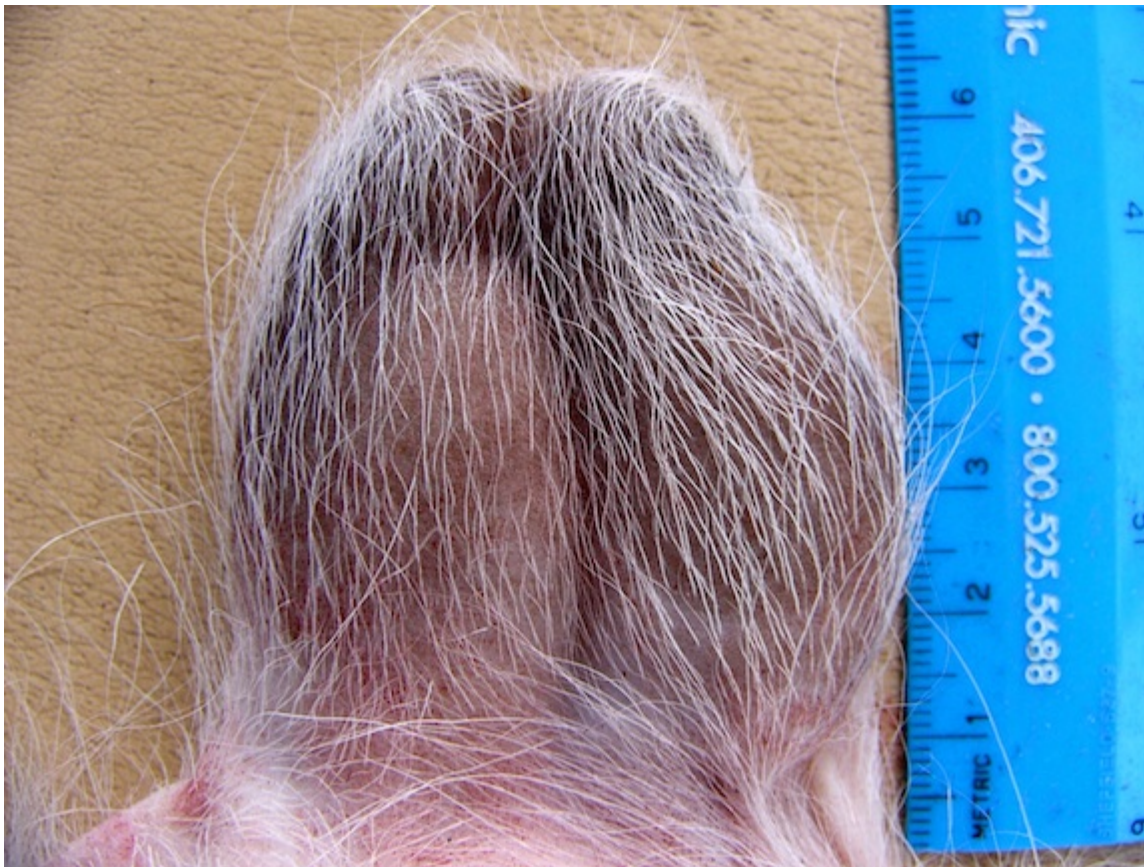
The first set of photographs below show normal placement, size and form of the genital organs on a white-tailed deer. On normal male mammal genitalia, the hemiscrota or compartments in the scrotum for each testis on the external skin are formed early in development in a bilateral position. This scrotal configuration is described with photos of a normal adult male white-tailed deer on **pages 3 - 7**. A normal scrotum contains the testes in a bilateral position perpendicular to the spine with the midline running between the two testes. If the scrotum is long enough to contain the testes away from the body wall and the scrotum has a "neck" or narrower area between the hemiscrota and the body wall, the scrotal sac can be turned either direction by leg pressure. This often happens when an animal is dead. If the hemiscrota are in a bilateral position during fetal development, the hemiscrota will always return to a bilateral position when the legs of the dead animal are spread. Unless otherwise noted, the photos were taken of animals born in Ravalli County, Montana.



This is a side-view of a normal white-tailed deer genitalia removed from the deer with skin still present. Taken straight from the right side, only one hemiscrota, the right hemiscrota in this photo, is visible. This is how a normal white-tailed deer scrotum looks from the side. Compare this normal configuration with the malformed scrotum in the photo on **page 1**. Note the teats are positioned between the rear of the penis sheath and the anterior of the scrotum. In this photo anterior is to the right.



Looking down at the same normal 2 1/2 year old white-tailed deer genitalia. The penis sheath is normal in length (between 6 cm and 7 cm from the body wall to the tip of the sheath) and the scrotum is normal in length with bilateral hemiscrota and midline running between the two hemiscrota. The teats are in a normal position with the front teats immediately behind the base or root of the penis sheath and the hind teats anterior to the base of the scrotum. Thus, the teats are located midway between the penis sheath and the scrotum, as they were on all male deer observed prior to spring of 1995. A vehicle killed this deer. Anterior is to the left in this photo.



This is a close-up photo of the normally placed bilateral hemiscrota. This is the same white-tailed deer scrotum shown in the photo above. Note that this scrotum has a neck or narrower area at the base of the hemiscrota, so the testes are contained away from the heat of the body wall.



This is a photo of testes and penis with the outer skin removed. This genitalia was from a 3-year-old white-tailed deer with normal bilateral testes.



This is a side-view of the above normal genitalia with skin removed. Note the gland posterior to the penis, the right inguinal lymph node, was formed in the normal location on this animal and is directly opposite the left inguinal lymph node. Anterior is to the right in this photo.

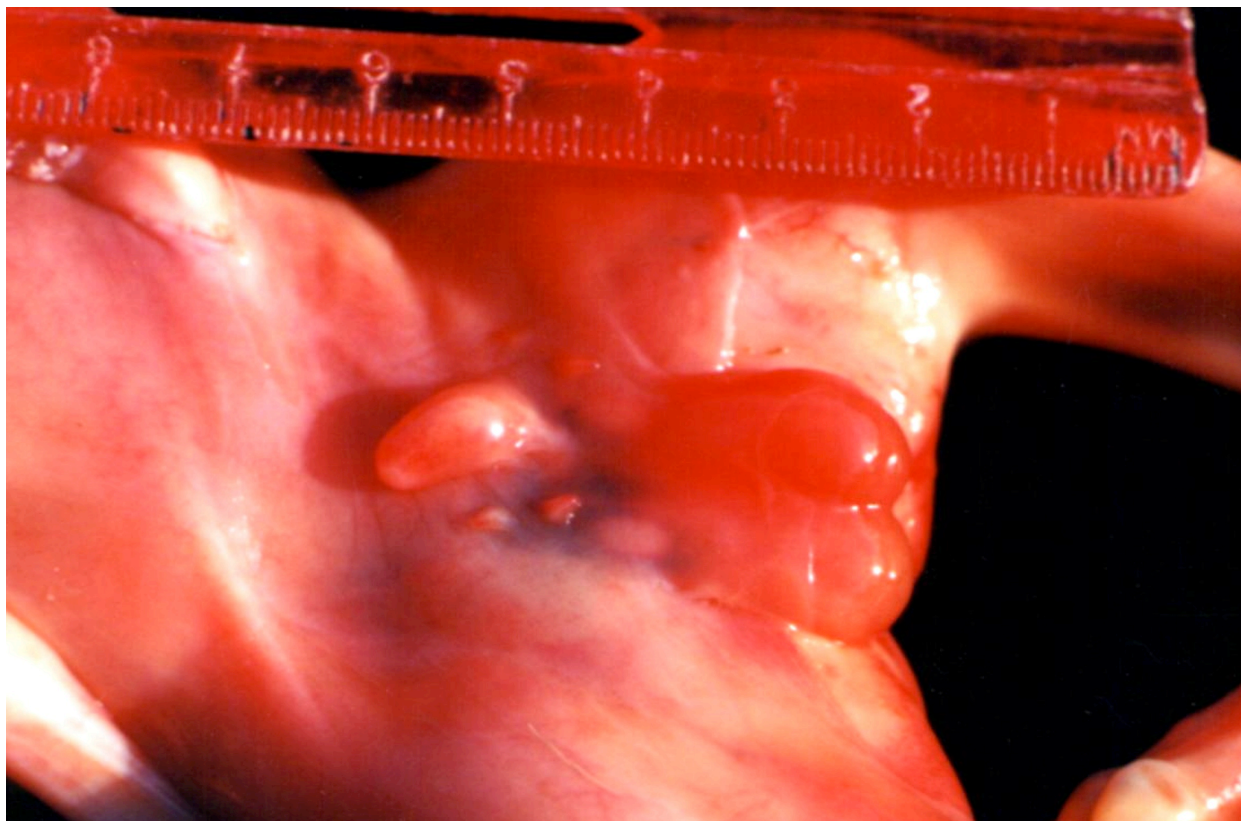


This photo shows a close-up of the normal hemiscrota shown in the photos above. It clearly shows the midline running over the hemiscrota directly between the two testes.



This photo shows the testes from a normal adult white-tailed deer and the measurement of the testes in centimeters. Occasionally, the measurements of one testis will be slightly greater than the other, but on nearly all testes that I measured from ungulate species here in Ravalli County, the testes were very similar in size. Of hundreds of white-tailed deer measured, only two had one testis significantly smaller than the other, well within a normal range for a mammal population. Difference in size of testes was not an issue.

THE TIMING OF THE DISRUPTIONS OF DEVELOPMENT RESULTING IN THE MISALIGNMENT OF THE HEMISCROTA DURING THE DEVELOPMENT OF THE GENITALIA ON MALE WHITE-TAILED DEER (*Odocoileus virginianus*) FETUSES.



This photo shows an unhaired white-tailed deer fetus with normal genitalia. The penis sheath is normal in length and the scrotum is comprised of bilateral normal sized hemiscrota.

The next two photos on **page 9** show two different male white-tailed deer fetuses at a stage of fairly early fetal development. These twin fetuses died when the mother was killed near the last week in February, approximately 3 months prior to birth. The penis sheath and scrotum were fully formed on the fetal skin. The penis sheath on both fetuses was fairly normal in length for a fetus of this age. The scrotum on both was much shorter than normal and shorter than the penis sheath. The scrotum is normally longer, measured from the body to the tip of the hemiscrota than the penis sheath on a white-tailed deer. It is easily observed that on both fetuses the left hemiscrota was formed directly forward of the right hemiscrota. There is no possibility of “twisting” the scrotum (two hemiscrota) on these two fetuses to any other position.





A partly haired male fetus with the left hemiscrota formed mostly forward and partly separate from the right hemiscrota.



This photo is of the inguinal lymph nodes on an adult white-tailed deer with misaligned hemiscrota. The left inguinal lymph node at top of photo, as can be seen, is significantly forward of the right inguinal lymph node just above the 1 inch mark on the ruler. It is this initial malformation early in fetal development, which causes the left testis to descend forward of the right testis and form the left hemiscrota directly forward of the right hemiscrota. This malformation is clearly not caused after the animal is born or caused by the legs being too tight together, as some personnel in state and federal agencies have stated or suggested without looking for the actual developmental mechanism that is disrupted. Anterior is to the right in the photo.

The described series of malformations to the male reproductive organs occurs early in fetal development prior to and during the period when the genitalia is formed on the fetal skin. This completely belies a statement in the Montana Department of Fish, Wildlife and Parks report Ravalli County White-tailed Deer Survey (RCWTDS) (Aune and Anderson, 1997), concerning a male white-tailed deer with misaligned hemiscrota. The 1 ½ year-old deer was taken to the MDFWP Laboratory in July of 1996, by the Missoula MDFWP biologist, John Firebaugh. The RCWTDS report states, "The scrotum was twisted 90% but this appeared to be a postmortem change, in that the inguinal rings and spermatic cords were in normal position." Actually, because the left inguinal lymph node is misplaced forward on these animals, the left spermatic cord is also misplaced forward

as it is positioned directly anterior to the left inguinal lymph node. My colleagues and I consider the forward positioning of the left spermatic cord (**see photo page 11**) to be a birth defect as it is present on the animal at birth and is not normal.

Another report by Michael Dunbar at the National Wildlife Health Center in Madison, WI, stated concerning several prosected white-tailed deer genitalia with misaligned hemiscrota I sent to him, "Although several scrotal sacs were not in a perpendicular axial alignment with the body axis, it is believed to be normal due to limited space between the hind legs where the scrotums are located." There does not appear to be limited space between the hind legs on the fetuses (**page 9**) of ruminants or on any other animal on which we have documented this birth defect, including canines and rodents. This condition is a congenital reproductive malformation and occurs because of misplaced organs, including internal organs, during fetal development.



A photo showing a slightly older male white-tailed deer fetus genitalia that has bilateral hemiscrota and is within normal range in size and distance down from the body wall. Note, the hemiscrota are in a perpendicular axial alignment with the body axis and the midline goes between the testes. It would be impossible to turn this animal's hemiscrota into the position of the hemiscrota on the two fetuses in the above photos. The scrotum is normal in length for the age of the fetus and much longer in comparison to the penis sheath than the misaligned scrotums on the two fetuses in the above photos. However,

the fetus's scrotum did vary somewhat from the norm. There is a slight split between the hemiscrota and there is not a neck or narrower area between the testes and the body wall, and in fact, this scrotum is widest at the neck, where the hemiscrota attach to the body wall.

ABNORMAL GENITALIA ON NEWBORN AND OLDER DEER FAWNS.

Since, the shape and size of the penis sheath and the scrotum is determined when the genital organs are formed on the fetal skin, the relative length of the penis sheath and the scrotum for the life of the male deer remains the same after being formed. If the testes are in their respective hemiscrota, the enlarged testes during breeding season will stretch the hemiscrota somewhat wider, but a short scrotal sac will not grow longer. Neither will an animal born with no hemiscrota (scrotum) formed on the external skin as a fetus ever have a scrotum. If the testes go into a horizontal position between the skin and the body wall (referred to as ectopic testes) as a fetus, they will remain in that position for life. When the testes go into an ectopic position, only a very short bump or often, no scrotum at all, is formed on the skin. A short penis sheath will become wider and somewhat longer as the animal grows, but will remain relatively short for the life of the animal. Stated another way, whatever the original configuration of the genitalia on the fetal skin is how a male's genitalia will be for life.



This is a photo of a bilateral scrotum on a newborn white-tailed deer. The scrotum is quite short, being shorter than the penis sheath and very wide at the base, with no neck. Because the scrotum is so short, both testes are partly ectopic. The teats were between the posterior root of the penis sheath and the anterior of the scrotum.



This is the genitalia of a newborn fawn with malformed genital. The hair was removed to more clearly show the left hemiscrota, where it was formed directly forward of the right hemiscrota. Also note the very short penis sheath, much shorter than on a normal unborn fetus. For comparison, see the penis sheath on the un-haired fetus on **page 8** with a normal length penis sheath.



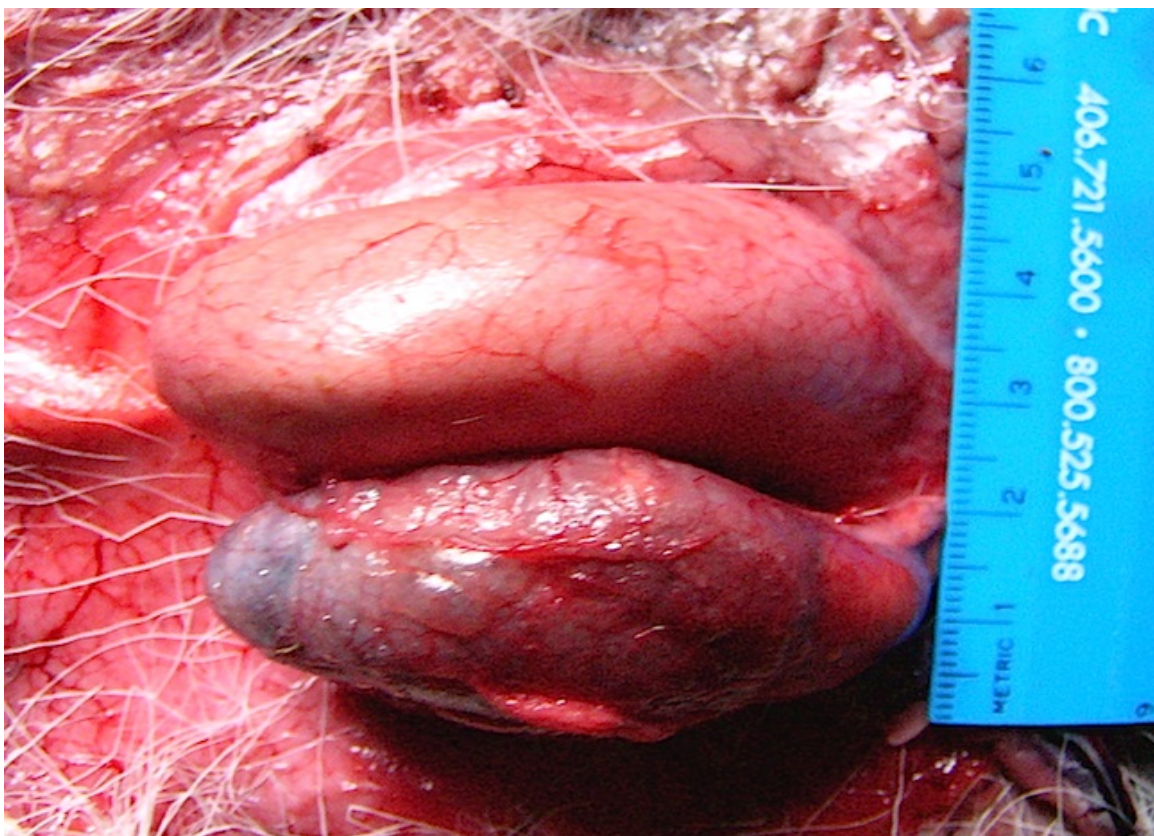
On this newborn white-tailed deer fawn genitalia both the penis sheath and the misaligned scrotum are extremely short. The testes were ectopic and horizontal against the body wall on this animal, thus reproduction would have been affected, if it had lived to be an adult. Note the abnormally long distance between the posterior root of the penis sheath and the anterior base of the scrotum on this fawn's genitalia and the genitalia of the newborn fawn with misaligned hemiscrota on **page 15**. The difference between the scrotum and the penis sheath on this fawn's genitalia and the fawn's genitalia on **page 15** to the same area on the fawn's genitalia on **page 14** is significant.

PHOTOS OF THE GENITALIA OF A WHITE-TAILED DEER TO ILLUSTRATE THE FORMATION OF ONLY ONE HEMISCROTA ON THE EXTERNAL SKIN.



This photo shows the size and shape of the one hemiscrota containing the left testis, which is tipped far backwards. The photo also shows the length of the penis sheath.

The second photo (**page 18**) shows both testes after the skin was removed to expose them. The left testis was in the hemiscrota, forward of and below the right testis (when the deer is standing). The right testis was ectopic between the body wall and the left testis, with no hemiscrota formed for it. In the photo, the left inguinal lymph node is visible just behind the left spermatic cord. The spermatic cord (right under the 6 cm mark on the ruler) can be seen curving forward around the inguinal lymph node. Because the left inguinal lymph node is formed forward of normal before the testes descend to form the scrotal sac (the hemiscrota) on the fetal skin, the left testis descends into an abnormal position directly forward of the right testis. If the testes are tipped backward as these are, the left testis goes into a position directly below the ectopic right testis, as shown in the photo.



This photo shows a top view of the horizontally formed hemiscrota on the skin, which I turned inside out. The left testis is beside the external skin, which covered the testis until I removed it. The right testis is not visible because it is directly below the left testis.

PHOTOS OF WHITE-TAILED DEER OF VARIOUS AGES WITH THE LEFT HEMISCROTA FORMED DIRECTLY FORWARD OF THE RIGHT HEMISCROTA.



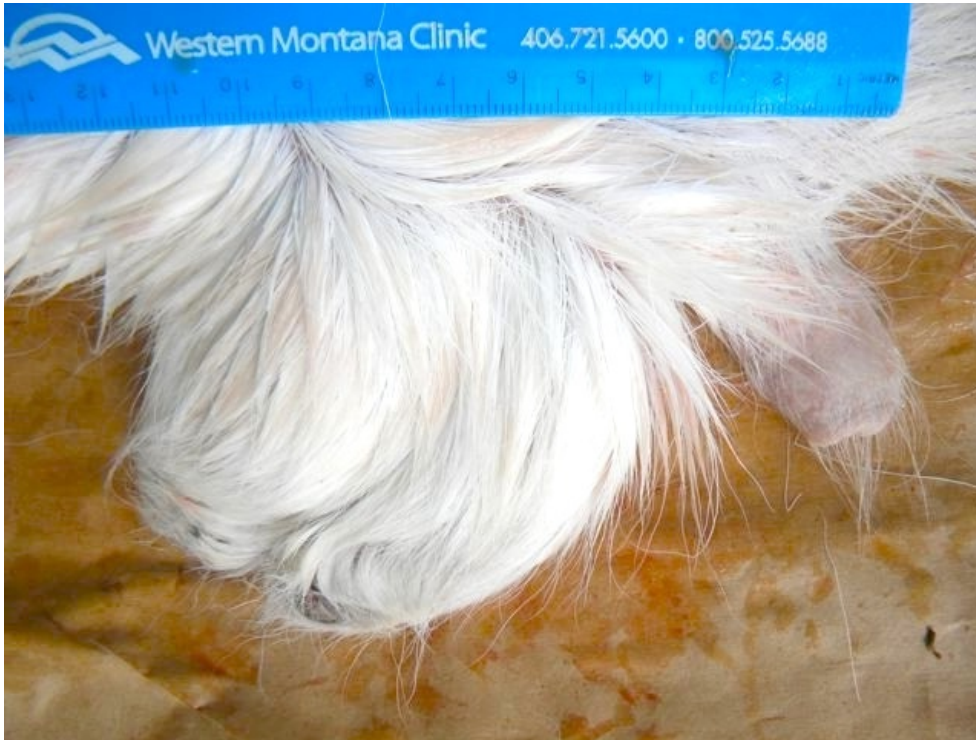
On this newborn male white-tailed deer fawn, both the penis sheath and the scrotum are very short. The hemiscrota are clearly misaligned with the left hemiscrota directly forward of the right hemiscrota. The small bump on the skin at the base of the short flap of skin that is the scrotum indicates the position of the horizontal right testes, which is ectopic under the skin. Again this fawn has a long distance between the scrotum and the penis sheath. Anterior is to the right.



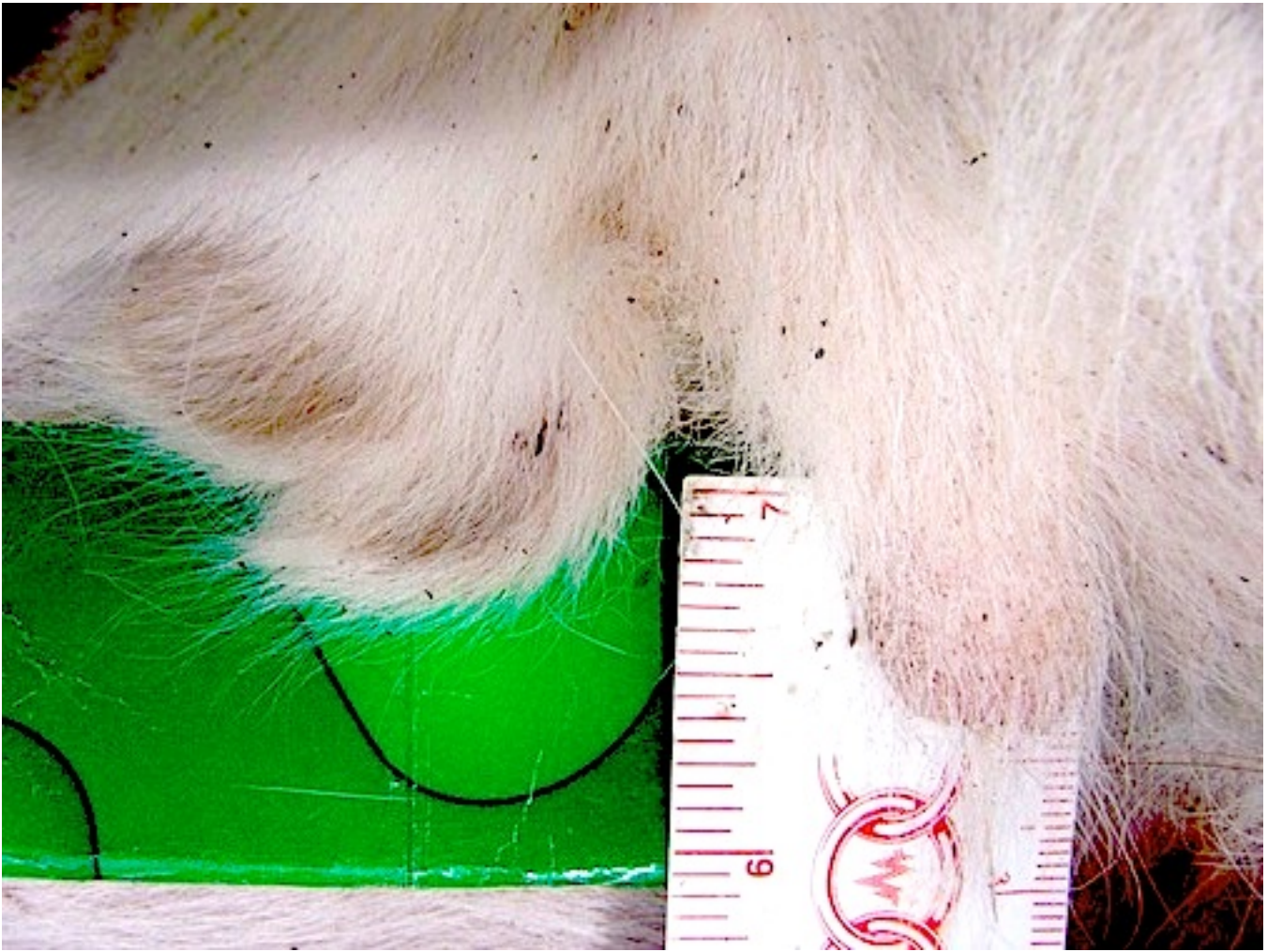
This photo shows the empty genital skin from an older white-tailed deer fawn. Only the left hemiscrota was formed on the external skin. The right testes was ectopic, the left testes was in the hemiscrota. The penis sheath is fairly normal in length. Note the much shorter distance between the rear base of the penis sheath and the anterior of the hemiscrota than in the fawn genitalia on the page above. An extremely long distance between the anterior base of the scrotum and the penis began being observed on many male ruminants at the same time as the other malformations. Except for misaligned hemiscrota and an abnormally long distance between the scrotum and the penis sheath, all other observed malformations are reported symptoms of disruption of the fetal thyroid hormones in studies where ruminant young have been deliberately caused to have thyroid hormone disruption during development. I could not find the misaligned hemiscrota or the abnormally long distance between the scrotum and the penis sheath reported in the scientific literature. Anterior is to the right.



This is an older white-tailed deer fawn genitalia, with misaligned hemiscrota and hemiscrota tipped far to the rear, causing the right testes to be in contact with the body wall. The penis sheath is somewhat short, not normal in length, but not extremely short. Anterior is to the left.



This is the genitalia from a hunter-killed adult white-tailed deer with similar scrotal configuration to the fawn in the top photo, with the left hemiscrota directly forward of the right hemiscrota. The penis sheath is about half the length of a normal adult. The testes were enlarged because the deer was killed during breeding season.



This older white-tailed deer fawn has very short, misaligned, separated hemiscrota with the right hemiscrota being even shorter than the very short left hemiscrota. Note the penis sheath is short, but is longer than the double hemiscrota. Anterior is to the right.

ADULT WHITE-TAILED DEER PROSECTED DRIED GENITALIA SKINS SHOWING VERY ABNORMAL GENITALIA.



This is the dried skin of the genitalia of a two-year-old white-tailed deer. Note the penis sheath was less than 3 cm. A normal adult white-tailed deer penis is usually more than 4 cm. The left hemiscrota was formed directly forward of the right hemiscrota and the testes were in the hemiscrota, but partly ectopic because both hemiscrota were very short. Anterior is to the right.



This is the dried skin with hair removed of the genitalia of a two-year-old white-tailed deer. The penis sheath was normal in length. The left hemiscrota was formed almost directly forward of the right hemiscrota. The hemiscrota were formed completely separated. A conference of over 300 scientists, doctors, veterinarians, etc. looked at this scrotum and said the animal had a serious, almost unbelievable, reproductive malformation. Anterior is to the right.

WHITE-TAILED DEER GENITALIA WITH NO SCROTUM FORMED.



No scrotum was formed on this 2 1/2 year old white-tailed deer during development. The ectopic testes are bilateral and horizontal. The points of attachment clearly show on the inside of the skin at the tips of the normal sized testes. Anterior is to the right.



This is a photo of the same genitalia as in the photo above, which has no scrotum formed on the external skin and the ectopic testes are horizontal under the skin. The bumps in the skin show where the horizontal testes pushed up the skin slightly when the genitalia was placed on a flat surface (done deliberately so the bumps would show where the scrotum should have been formed). Anterior is to the left.



This 1 1/2 year old male white-tailed deer had the teats formed far forward of the normal groin area. Then the genitalia was formed forward of normal, as the teats are formed earlier in the development of the fetus than the male genitalia. As a result of being formed forward, the testes are in a tipped backward, horizontal position. The penis sheath and teats are forward of the front of the hind leg. Also, the front teats are even with the anterior of the root of the penis sheath. The teats, as shown in the photos above of a normal male white-tailed deer, are normally between the rear of the root of the penis sheath and the anterior of the scrotum. The teats should not be even with or forward of the anterior of the root of the penis sheath.

As a result of the left inguinal lymph node being formed forward of the right inguinal lymph node prior to the formation of the spermatic cords, the left spermatic cord is somewhat forward of the right spermatic cord. (See the photo on **page 11** of the placement of the lymph nodes on another male white-tailed deer.) This results in the left testis descending through the left spermatic cord in a position forward of the right testis in the right spermatic cord when the testes descend to form the scrotal sac on the malleable fetal skin. On this animal, because the left testis was forward of the right testis and the testes descended in a tipped back mostly horizontal position as a result of the abnormal forward position, the right testis ends up in an ectopic position between the body wall and the left testis. The right hemiscrota is thus mostly unformed and neither testis is contained in a position away from the body heat. Thus the sperm of this animal was likely to be heat damaged. The teats on this animal are similar in size to a female white-tailed deer of the same age and slightly larger than usually seen on a male white-tailed deer of any age. The penis sheath is only 1.3 cm long, much shorter than on a normal male white-tailed deer of this age or any age after birth.

ABNORMAL MULE DEER (*Odocoileus hemionus*) GENITALIA.



This is the dried genitalia of a newborn mule deer fawn. The scrotal sac was just a tiny flap of skin where the scrotal sac should have been (directly above the 3 on the ruler). The normal sized testes were horizontal in a bilateral position between the skin and the body wall. Thus the testes were ectopic between the skin and the body wall, similar to the testes position in the photos of an adult white-tailed deer genitalia with no scrotum formed on the skin on **page 24 and 25**. A very short flap or two flaps of empty skin is the same as no scrotum with regard to affects on the functions of male genitalia. The penis sheath was fairly long and appeared to be normal for a newborn mule deer. The penis sheath is directly above the 7 on the ruler and is hard to see because of the hair. Anterior is to the left.



11/4/00 shot 11/3/00
Mule Deer Ad.
East of saddle-
Claremont Creek,
Montana.
~~♂~~ Jaw Malocclusion

This photo shows the skin of a scrotum taken from a hunter-killer adult mule deer shot in November of 2000 and brought to me by the hunter. The left hemiscrota was formed directly forward of the right hemiscrota, similar to the same malformation on white-tailed deer shown in several previous photos. The removed testes (shown to the right in the photo) were normal in size and were in the corresponding hemiscrota. The penis sheath is normal in length and longer than the abnormally short scrotum. This male mule deer also had brachygnathia superior and resultant underbite.



This photo shows the genitalia on the carcass of an accident-killed four-month-old mule deer fawn. This male fawn had an extremely short almost not formed bilateral scrotum. The penis sheath was fairly normal in length. Anterior is to the right.

ELK (*Cervis canadensis*) MALE GENITALIA SHOWING THE SAME BIRTH DEFECTS OF THE MALE REPRODUCTIVE ORGANS.



This dried genitalia is from a hunter-killed adult male elk harvested in 11-2005. The penis sheath is at the extreme left of the photo. The left hemiscrota on the scrotum is formed directly forward of the right hemiscrota, similar to the misaligned hemiscrota on other ruminants shown in this document.



This photo is a close-up of the dried elk scrotum shown in the above photo. The testes were in the hemiscrota when the scrotum was brought to me by the hunter.



A live bull elk with a normal bilateral scrotum with bilateral hemiscrota as has historically been the normal scrotal configuration on a male ruminant.



This photo shows a live adult male elk with the left hemiscrota formed directly forward of the right hemiscrota. Obviously this elk was born with this scrotal configuration. Eugene Beckes took this photo at the National Bison Range north of Missoula, MT.

PRONGHORN ANTELOPE (*Antilocapra americana*):

While I have not seen genitalia from pronghorn antelope from Montana, photos in hunting magazines indicate the problem is very widespread and occurs on antelope in other states (see photo of an antelope from New Mexico on **page 33 and 34**). Additionally, I measured and photographed a vehicle-killed male antelope in Nevada. That animal had a very short misaligned scrotal sac (see photo on **page 35**).



A photo of a pronghorn antelope killed by a hunter in New Mexico. Note in the photo on the right, the scrotum is visible and the hemiscrota are obviously misaligned. This scrotum does not appear to have simply been turned by leg pressure because it has an abnormal elongated shape. Leg pressure does not cause a scrotal sac to be an abnormal shape. Also, it would appear to be completely impossible for this scrotal sac to be able to be turned to a normal bilateral position.



This photo is a cropped close-up of the genitalia of the male antelope in the magazine photo. By the shape of the scrotum, it is easily seen the left hemiscrota was formed directly forward of the right hemiscrota. The testes were away from the body, thus this male antelope would likely have had viable sperm and thus pass this epigenetic change to its offspring. Anterior of the animal is to the right.



This photo shows the scrotum of a vehicle killed male pronghorn antelope found by the roadside in Nevada. The anterior is to the left. Note the teats are visible to left of the scrotum. This scrotum was a short flap of skin with the left hemiscrota formed directly forward of the right hemiscrota. The testes could be palpitated in a horizontal position under the skin. Neither testis was in the scrotum. This scrotum was not long enough to be turned in either direction. The hindquarters and genital area were not damaged by the impact.

BISON (*Bison bison*)



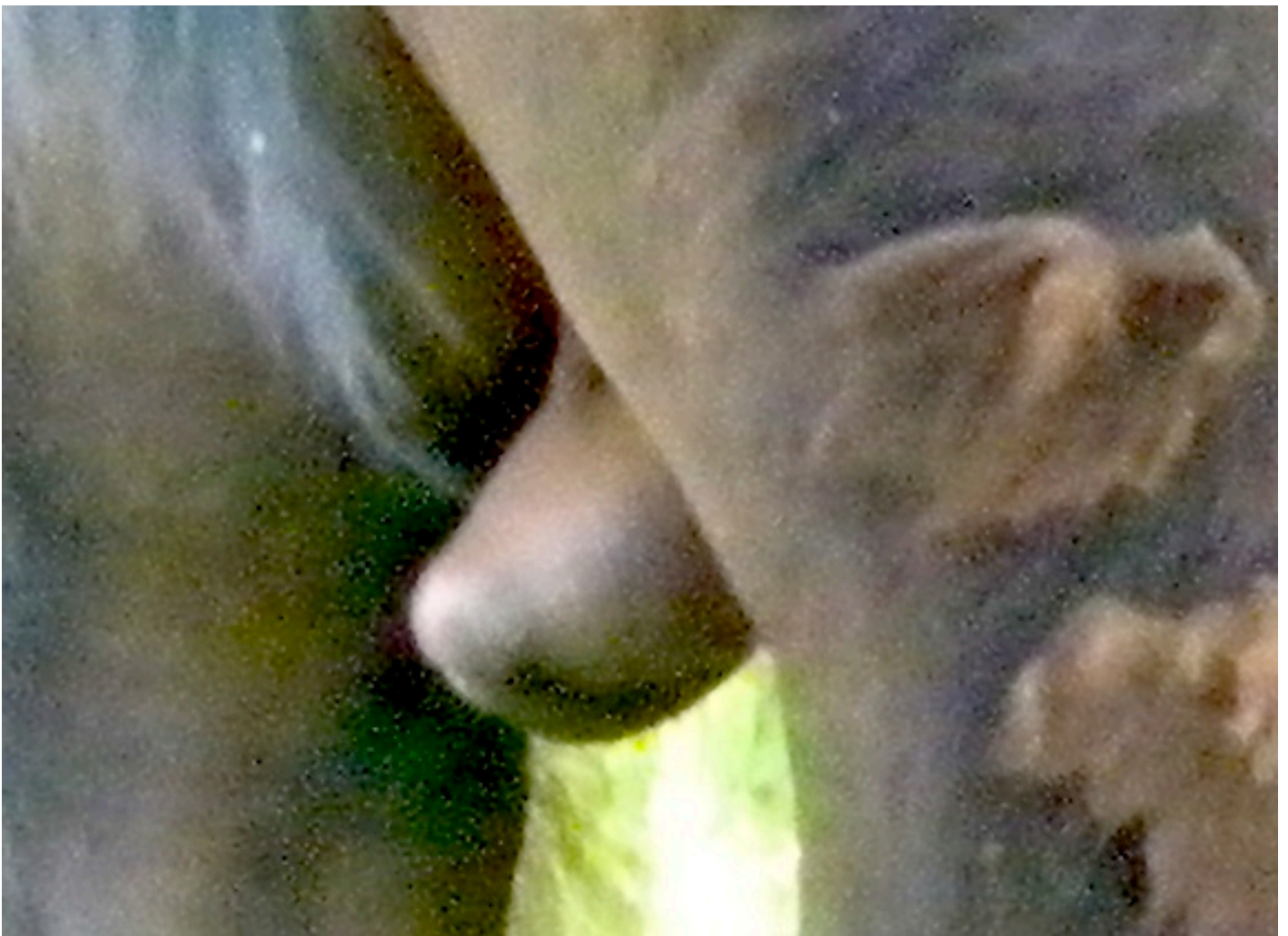
An adult male bison photographed at the National Bison Range, north of Missoula, Montana. This bison has a normal length, easily seen, bilateral scrotum that contains the testes well away from the body. This photo was taken by Eugene Beckes.



This bison's hemiscrota were misaligned with the left hemiscrota forward of the right. Compare this scrotal configuration with the normal scrotum on the bison above.



The scrotum on this live adult male bison has the left hemiscrota formed directly forward of the right hemiscrota. The legs on this animal are obviously not tight together, thus the legs are not squeezing the scrotal sac into this position. As with all the other misaligned scrotal sacs pictured for other animals, this bison was obviously born with the hemiscrota misaligned, and thus this scrotal configuration is a birth defect. The testes are completely contained in the scrotum away from the body wall. Reproduction should not be affected on this bison. This type of change is likely an epigenetic change and so would be passed on to future generations by this and other such males. This photo was taken in Yellowstone National Park. A large number of bison in YNP have misaligned hemiscrota, and many have a very short or almost no scrotum. It is unknown why this is not being addressed, as the bison in YNP are one of the genetically purest herds and a high prevalence of such birth defects in this population should be very concerning.



Male bison in Yellowstone National Park have a variety of abnormal scrotal configurations, from very short bumps to those with tipped back misaligned hemiscrota. These scrotal configurations are not normal variations. They are serious birth defects.



This adult male bison had very short scrotum, almost not visible and much shorter than on a bison with a normal scrotum. This bison was photographed in the Lamar Valley of Yellowstone National Park and appeared to be at least 6 years old. The testes are not contained away from the body wall. The testes being too warm, causing heat damage to the sperm would likely adversely affect reproduction. The hemiscrota and testes are in a bilateral position as can be seen by the position of the midline on the scrotal sac.



This National Bison Range bull bison has only a very short bump where a scrotum should be. This bison's short scrotum is simply a bump on the external skin where the testes are located in a horizontal ectopic position, resulting in a bump where the scrotum should be. Photo by Eugene Beckes.



This Yellowstone National Park bull bison photographed in the Lamar Valley has a misaligned scrotum with the left hemiscrota directly forward of the right hemiscrota and both hemiscrota tipped far backward. A high prevalence of males of wild ruminant species are now born with this misaligned scrotal configuration, often with the misaligned hemiscrota tipped far to the rear as on this bison.