DEVELOPMENTAL HORIZONS AND MEASUREMENTS USEFUL FOR AGE DETERMINATION OF EQUINE EMBRYOS AND FETUSES

by

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INTRODUCTION

There are over six million horses in the United States today. This figure is double the number recorded in 1960. The light horse may be the fastest growing segment of the livestock industry.

The present day equine exists for only one basic function ... locomotion. In this athletic capacity, vigorous post-natal growth is considered essential for the production of high performance race, rodeo, and work horses. However, little or no emphasis has been placed on the importance of normal pre-natal growth and development of the equine species. Prenatal life is an extremely critical period as interactions of numerous factors such as nutrition, disease, and genetics determine whether or not the developing organism grows at a normal rate.

An attempt was made in reviewing the literature to approach previous equine embryological studies in the order of appearance of developmental horizons and growth changes from conception to full term of gestation.

Van Niekerk (1965) stated that the blastocyst is 2.5 X 1.5 cm by 14 days, 5 cm in diameter by 16 days, and 6.1 cm by 17 to 21 days after ovulation. Zietzschmann and Krolling (1955) reported that the embryonic vesicle is 1.74 cm in length by 18 days and 3.25 cm by 2 to 3 weeks of gestation. Hafez (1962) mentioned the blastocyst acquiring a 3 to 4 mm albumin coat by the third week of gestation and the appearance of trophoblastic discs on the wall of the chorion. According to Van Niekerk (1965) the allantois commences to develop by 21 days after ovulation when the crown-rump length of the embryo is 7.5 mm and the yolk sac is 6.7 x 6.4 cm.

Zietzschmann and Krolling (1955) reported that the crown-rump measurement of a 28-day old embryo is 1 cm and Craig (1930) stated that such a specimen is 1.27 cm long at that age. Roberts (1956) stated that a 30-day old embryo is 1.9 cm long and Craig (1930) found that ovaries may be distinguished at this time. Sex character is determinable at 33 days of gestation according to Carlson (1929).

By seven weeks of gestation, the crown-rump length is 5 cm according to Zietzschmann and Krolling (1955), and 6.5 to 7.5 cm by eight weeks. Roberts (1956) reported 8-week old fetuses to be 5 to 7.5 cm long and weigh 5 gm.

At nine weeks of gestation the crown-rump measurement is 7.5 cm according to Stoss (1944), and 8 mm according to Zietzschmann and Krolling (1955). Stoss found that at this time, the allantois was 23 cm long and 13 cm wide and van Niekerk (1965) reported that it had replaced the yolk sac entirely. Zietzschmann and Krolling (1955) found the crown-rump length of ten week old fetuses to be 9 cm.

Stoss (1944) and Zietzschmann and Krolling (1955) agreed that 12-week old fetuses have a crown-rump length of 12 cm, while Roberts (1965) reported such subjects to be 7.5 to 15 cm long and weigh 60 to 120 gms. Zietzschmann and Krolling (1955) reported that 15 week old fetuses have a crown-rump length of 16.5 to 18 cm. Stoss (1944) stated that 16-week old fetuses have a crown-rump length of 20 cm, external genitalia are present, but testes remain in the body cavity and the prepuce undeveloped. Roberts (1956) reported that fetuses of such age are 12.5 to 23 cm long, weigh 0.9 to 1.3 kg and have hair on the upper and lower lips.

According to Zietzschmann and Krolling (1955), 17 week old fetuses have a crown-rump length of 22 cm. Stoss (1944) stated that 20-week old fetuses have a crown-rump length of 33 cm and hair on lips and eyelids. Zietzschmann and Krolling (1955) reported that the crown-rump length of 20-week old fetuses can vary from 33 to 37 cm while Roberts (1956) reported a range of 20 to 35 cm with a weight variation of 3 to 5 kg.

Zietzschmann and Krolling (1955) found that 24 week old fetuses have a crown-rump length of 48 cm and Stoss described the presence of single mane hairs and eyelashes. Roberts (1956) mentioned that fetuses of this age have hair present on lips, nose and eyebrows, are 35 to 64 cm long, and weigh 3 to 6 kg.

Stoss (1944) reported that the crown-rump length of 28 week old fetuses ranges from 40 to 70 cm, while Roberts (1956) found a length variation of 35 to 70 cm, weight of 4 to 7.5 kg, and described the presence of hair on the tip of the tail. Stoss (1944) described 32 week old fetuses as having a crown-rump length of 65 to 70 cm and the first appearance of hair on the external ear, back, and extremities. Roberts (1956) reported that fetuses of this age have a length of 50 to 70 cm and weigh 8.5 to 15 kg. Zietzschmann and Krolling (1955) stated that 34 week old fetuses have a crown-rump length of 68 cm.

By 36 weeks gestation, according to Stoss (1944), the crown-rump length of a fetus is 80 cm, and hair on the body is short and thin, but not noticeable on the abdomen and inside of the thighs. Roberts (1956) stated that 36 week old fetuses are 60 to 90 cm long and weigh 17 to 20 kg.

Stoss (1944) described 40 week old fetuses as having a crown-rump length of 90 cm with a prepuce present and markedly bulged brain case. Roberts (1956) reported fetuses of this age as having well developed mane and tail hair and a short hair coat completely covering the body. The range observed by Roberts (1956) of 40 week old fetuses was 70 to 132 cm in length and 25 to 45 kg body weight.

By 44 weeks of gestation, equine fetuses have a crown-rump length of 1 meter and the testes have descended according to Stoss (1944). Roberts (1956) described fetuses of that age to be 76 to 147 cm in length and 30 to 60 kg of body weight.

Zietzschmann and Krolling (1955) found 48 week old fetuses to have a crown-rump length of 100 cm while Stoss reported 1 to 1.5 meters, with a body weight of 40 kg and eruption of the deciduous incisors. Craig (1930) stated that full-term equine fetuses weigh 38 to 45 kg.

No report on equine embryology is reasonably complete and data on fetuses of the same age vary by as much as 50 per cent because of differences in techniques, variations between breeds and problems of age determination. In an effort to establish reasonable criteria for age determination of equine fetuses and concurrently analyze the growth characteristics, a study of horse reproduction was undertaken. The present study is an attempt to correlate external body measurements and weights of equine fetuses with their specific ages. In addition to developmental horizons this study included measurements of contour, crown-rump, trunk, hindfoot, forefoot, head, tail, ear, and width of head.

MATERIALS AND METHODS

Weights and measurements reported in this study were obtained by necropsy of control-bred mares.

Of the 110 embryos and fetuses, 63 were from Thoroughbred, 25 from Quarter Horse, 8 from cross-bred, 8 from Standardbred, 4 from Saddlebred and 2 from Arabian mares. All dams were 1000 lbs., plus or minus 100 lbs.

Data on length of contour, crown-rump, trunk, head, tail, ear, and width of head was obtained from 93 fetuses; on length of forefoot and hindfoot from 110 fetuses, and total body weight from 55 fetuses. Occasional lack of weighing facilities prevented obtaining complete data on fetal weight. In some instances, the size of term fetuses made storage impossible and only the fore and hindlimbs were available for measurement.

Body measurements were taken after the embryos had been fixed in 10 per cent buffered formalin. Embryos were freed of placental membranes, wiped with paper towel, and weighed on the same scale. Embryos and smaller fetuses were in some cases fixed in the uterus by perfusion through the uterine arteries and injection of formalin into the embryonic vesicle.

To obtain the straight measurements (head, crown-rump, trunk, hindfoot, forefoot, ear, and tail), vernier calipers, or in the case of larger fetuses, a metric rule was used. Contour measurement was obtained with a cord which was then measured on a metric rule.

All measurements were taken as described by Henry (1958):

Contour - length from the tip of the snout over the forehead, along the mid-dorsal line, to the tip of the tail.

Crown-rump - greatest length in a straight line from the tip of the forehead to the posterior surface of the thighs ventral to the tail.

Trunk - greatest length in a straight line from the point of the shoulder (Scapulo-humeral articulation) to the posterior surface of the thigh, ventral to the tail.

Head length - distance from the tip of the nose across the eye region to the top of the head.

Head width - distance between the lateral surfaces of each eyeball across the frontal surface of the head.

Hindfoot - length from the back of the heel (tuber calcis) to the tip of the hoof, with the foot flattened on the ruler.

Forefoot - length from the dorsal surface of the distal end of the radius to the tip of the hoof with the knee in flexion.

Tail - length from the base to the tip of the tail.

Ear - length from base to tip of dorsal surface of ear.

Observation of the time and order of appearance of differentiation and development of embryonic and fetal structures provided developmental horizons. Developmental horizons observed in this study include the appearance of the heart, optic vesicles, allantoic bud, somites, eyes, eyelids, eyelid closure, pontine fissure, oral and nasal openings, forelimb, hindlimb and tail buds, pharyngeal pouch, lens, pinnae, genital tubercle, penis, clitoris, mammary papillae, prepuce, vulvar lips, vibrissae, eyelashes, and body hair.

Ages of the 110 embryos and fetuses involved in this study were determined to be the period of time between the controlled breeding of the dam and collection of the specimen from the mare.

RESULTS AND DISCUSSION

A series of embryos and fetuses from 20 days to full-term illustrates changes in external and internal characteristics. Graphs illustrating changes in body measurements and weight include Figures 1-5.

Although Van Niekerk (1965) mentioned the blastocyst measuring 1.5 x 2.5 cm at 14 days, 5 cm by 16 days, 6.1 cm at 17 to 21 days after ovulation, no description of embryonal morphology was given. As a result of this study, the blastocyst at 20 days gestation was found to measure 3.5 x 2 cm and the contour of the embryo to be 1.2 cm (Figure 6). In no reference was the appearance of a 20 day old equine embryo described. The embryo possesses a heart, optic vesicles, recognizable cephalic and body regions and an allantoic bud ventral to a tail bud. Van Niekerk (1965) stated that the allantois appears at 21 days in the equine embryo.

By 24 days the allantois is 0.3 mm at its widest point and anterior to its base enters with the yolk stalk into the body of the embryo. The embryo itself is cresent-shaped with the allantois being located on the caudal portion of the lesser curvature. When held against bright light, the heart and somites are easily detected. Van Niekirk (1965) reported that nidation of the blastocyst occurs 25 days after ovulation. It is doubtful if such a phenomenon exists in the equine species. In this study it was found that direct attachment between maternal and placental or fetal tissue, does not exist until villi proliferate on the chorionic surface of the chorio-allantois.

Placental attachment did not occur until after 80 days of gestation, when the chorionic villi become highly developed. Nidation, or implantation of the fertilized ovum into endometrium, does not occur in the equine species. The embryo or fetus, with its placental membranes, is relatively free floating until the third month of pregnancy. It appears that prior to this time placental fluids provide pressure for contact with the endometrium.

Description of embryonal morphology is lacking for subjects under 30 days of age and little has been reported for fetal development thereafter. In 26 day old embryos, the most salient feature of the cephalic region is the pontine fissure in the form of an equilateral triangle when viewed laterally (Figure 7). The transverse, transparent fissure offers an important aging criterion not only for its consistent appearance by 26 days, and disappearance by 36 days, but for its methodical, easily measured closure. The eye is also easily seen at 26 days, as a 0.5 mm round macule 1.5 mm caudal to the frontal surface of the head. The oral cavity is a potential slit about 2 mm from left to right commissure. The appearance of fore and hind limb buds at this age are also important developmental horizons for aging embryos, as is the tail which has increased to 6 mm in length.

While the pontine fissure was 3 mm at its widest point with an angle of about 45^{o} by 26 days of age, 28 day old embryos display a 2 mm fissure in the shape of a 30^{o} angle when viewed laterally. The s-shaped first pharyngeal pouch is 2.5 mm caudal to the oral opening and is in the form of a fissure 1.5 in length. Marked cervical flexion and lack of a recognizable nasal region contributes to the deceiving

location of the first pharyngeal pouch, lying close to the ventral surface of the cephalic region. Recognizable legs have replaced limb buds by 28 days of gestation.

Craig (1930) stated that the ovaries of 30 day equine embryos can be seen. Whether ovaries of such specimens were observed grossly, subgrossly or microscopically was not mentioned. In this study it was observed that at 30 days, sex character may be determined only histologically as a second set of Pfluegers cords have formed along the periphery of the female gonads but not on those of the male. There is no gross external evidence, however, as to the sex of a 30 day old equine embryo since the only existing structure in the genital region is a genital tubercle, that is 1 mm long, located between the hindlimbs and has yet to commence migration.

By 30 days, the pontine fissure has closed to a 20° angle and is 1.5 mm wide at its base. A rudimentary ocular lens has formed and although palpebra are not formed, the first evidence of a fold for the pinnae from the first pharyngeal pouch is seen. Mild carpal and tarsal flexion is now seen in the fore and hindlimbs respectively (Figure 8). When held against bright light, one can observe the location of the heart, liver, and cartilagenous centers of the appendicular skeleton.

It is proposed from this study, that 30 days is the turning point from embryonal to fetal development. Histological studies revealed evidence of not only gonad differentiation, but the presence of an olfactory lobe, a heart composed of atria joined by an interatrial foramen, and ventricles with chordae tendinae. Hepatic cord cells are

also present, as well as a fully formed mesonephros, an early metanephros and a pancreas.

By 33 days of age, the pontine fissure has closed to a 1 mm transverse slit. Carlson (1929) stated that sex character is determinable at 33 days of age, but again, method of observation was not mentioned. It was found, in the current study, that the genital tubercle is 1 mm long at this time and has not yet migrated. No external indication of sex character was noted until the 40 to 45 day age period. By 35 days, the pontine fissure is nearly closed and the nasal region has become apparent (Figure 9). The pontine fissure has closed entirely by 36 days indicating near maximal development of the pontine flexure. Cervical flexure has maintained the rostral half of the head between the forelimbs. The development of sharply tapering feet makes a specimen of such age easily recognizable as a soliped.

Palpebra are distinguishable by 40 days and the fold dorsal to the first pouch has molded into a rudimentary pinna. Although a penis or clitoris is not grossly recognizable, the genital tubercle has commenced to migrate anterior or posterior depending on the sex character of the fetus. At 40 days external nares become visible and the elbow and stifle regions roughly assume the typical appearance as seen in the post-natal equine (Figure 10).

By 45 days gross external sex determination is possible. The clitoris in a female fetus is located along the posterior border of the perineal region and extends in a posterior direction on a horizontal plane. The penis of a male fetus is located in the anterior inguinal area and extends in an antero-ventral direction.

Although the palpebra have proceeded to cover the ocular orbits by 55 days, their superior and inferior occlusal borders are still 1 mm apart. The brain case has assumed prominence but cervical flexion is less marked (Figure 11). The pinnae completely cover the external auditory opening as a triangular fold measuring 2 mm from base to tip. The hock and fetlock regions have attained an appearance more typical of the post-natal equine. A pair of prominent vulvar lips extend dorsally from the clitoris while in the 55 day male, the raphe perinei extends posteriorly as a median line from the base of the penis to a point destined for the development of the scrotum. In both sexes, mammary papillae are represented by pale dots in the inguinal region, with a diameter of about 0.25 mm. Stoss (1944) reported that these papillae do not develop until the end of the third month of gestation. During the present study the fate of the mammary papillae in the male equine fetus was observed. They are merely papules lateral to the raphe perinei at 55 days and by 120 days they have been incorporated in the development of the prepuce. In the post-natal male equine, the vestiges of mammary papillae are represented by a pair of teat-like eminences along the antero-ventral border of the penile sheath.

A fetus is unmistakeably equine by 60 days of age. Although hair is not detectable, the palpebra have begun to close and the external nares are in the form of slits, 1 mm long and 0.5 mm wide. These palpebra are entirely closed by 62 days and the wall, sole and frog of the foot are easily recognized. Time of closure of the eyelids was observed in 5 fetuses ranging from 60 to 63 days and closure at 62 days appears to be a valuable aging criteria.

Cervical flexion is so slight at 75 days that the head and neck of such a specimen have attained normal posture. The points of the shoulder and hips have become apparent (Figure 12). Close observation of the inguinal area reveals that, functionally speaking, an equine fetus may have a prepuce as early as 77 days, although he is 115 days old before it assumes the pendulous nature more typical of the post-natal penile sheath. Stoss (1944) reported that the prepuce is undeveloped as late as 16 weeks of gestation, however, it was found in this study that 77 day male fetuses have a rudimentary housing for the entire body of the penis and lack only the appearance of the vestiges of the mammary papillae and the suspended appearance to assume the character of a post-natal prepuce. Due to semantic difficulties in establishing the exact nature of the prepuce this structure contributes little to objective aging of fetuses.

By 80 days, the scrotum of the male is readily seen as a pale oval eminence 7.5 mm long, 1 mm wide, 1 mm high, and located 20 mm caudal to the umbilicus. Digital palpation reveals no contents. In both sexes mammary papillae have developed into raised buds, but have not increased in size.

At 95 days, the orbital area has gained prominence in both width and height resulting in the appearance of exophthalmos beneath closed palpebra. The pinnae are 1 cm long and curl forward and downward. Muscle groups are easily recognized and conformation of the fetus can be evaluated at this stage. The coronary border of the hoof provides a raised line of demarcation of the foot from the rest of the limb. The developing hoof has attained a pale yellow color which also differentiates it from the rest of the limb (Figure 13).

From 100 to 120 days, the external developmental changes are few, except for the appearance of hair and further differentiation of external genitalia. The glans penis is not entirely enclosed by the prepuce but the clitoris has receded to its terminal position just inside the vulvar lips at the ventral commissure.

The observations of Stoss (1944) that 16 week old equine fetuses have external genitalia and undescended testicles agree with findings made during this study. However, Stoss (1944) reported that such specimens have an undeveloped prepuce. This study revealed that by 115 days this structure resembles that of the post-natal equine. Roberts (1956) reported that 16 week old fetuses have hair on the upper and lower lips which agrees with the observations reported here.

By 120 days, the prepuce is quite pendulous and displays the presence of a pair of mammary papillae on its antero-ventral border. Fine hair on the muzzle and chin and around the eyelids is also noticeable (Figure 14). The vulvar lips are slightly convex and meet below the ventral commissure to form the typical bulb beneath the vulva as seen in post-natal fillies. Stoss (1944) also found 20 week old fetuses to have hair present on the lips and eyelids.

The eyelashes have begun to emerge by 150 days, and the ergots of all four limbs have become prominent as raised papules about 5 mm in height and diameter (Figure 15). Palpation of the scrotum reveals a pair of internal structures that upon dissection are found to be the left and right gubernacula enclosed in their vaginal processes. Until 300 days gestation, no further testicular descent occurs, however, the gubernacula, vaginal processes and scrotal sacs continue to grow. The

mammary gland of the female has attained a glandular shape and prominence. Appendicular growth becomes relatively more rapid than axial growth after 150 days, and continues at an accelerated pace until birth of the foal. Stoss (1944) reported that single mane hairs appear by 24 weeks gestation but it was found in this study that early mane and tail hair is difficult to detect until the fetus approaches 180 days. Roberts (1956), however, did not mention tail hair being present until the 28th week of gestation.

By 210 days gestation, mane hair is 2.5 mm long and thins out as it nears the poll and withers (Figure 16). Body hair is not yet detectable. The mammary gland of the female has attained a more typical suspended attitude.

Stoss (1944) described the hair of a 32 week equine fetus as located on the mane, external ear, back, and in the form of two strips on the tail. It was found in this study that a 240 day equine fetus has hair on both surfaces of the pinnae and over the poll. Whiskers are profuse on the throat, chin and muzzle and mane hair is 5 mm long and maintains its length along the crest of the neck. Hair covers the posterior half of the tail.

The body is covered by a coat of fine short hair by 270 days gestation. Although this hair is easily detected if the fetus is destined to be a bay, brown or black, chestnut and palomino fetuses appear denuded at this stage unless observed closely. Mane hair is about 1.5 cm long and is thickened. The tail which has been covered with hair for about 90 days now possesses a short switch. According to Stoss (1944), 36 week old equine fetuses have hair that is short and

thin on the body but not yet noticeable on the abdomen and inside the thighs. However, it was found in this study that hair is present on the ventral abdomen and inside the thighs, but is seen only under close observation.

Roberts (1956) described 40 week equine fetuses as having a well developed mane and tail and short hair completely covering the body. Such observations were made in this study on fetuses approximately two weeks earlier in gestation. Stoss (1944) described the appearance of an enlarged brain case at 40 weeks of gestation, however, in this study such a phenomenon was first observed in 55 day old fetuses. The enlarged brain case becomes quite indefinite during the last month of pregnancy and therefore is of little value in aging equine fetuses. Stoss (1944) also reported that 40 week old fetuses have a developed prepuce, however, this feature can be noted as early as 77 days and by 115 to 120 days it has developed the appearance of the adult structure.

The hair coat of a 300 day fetus is essentially the same as that of a full-term foal except for a greater degree of thickness in the latter (Figure 17). The teeth have not erupted. The sole and frog of the hoof are covered by a 1 to 2 cm keratogenous pad that is worn off during the first day of post-natal life. Roberts (1956) reported that 44 week fetuses have a normal hair coat, however, this statement should be interpreted to mean a coat of hair similar to that of a full-term foal. The report of Stoss (1944) that by 44 weeks the testicles have descended could not be confirmed from this study in which male fetuses of such age were found to have gonads within the inguinal canal and not in the scrotum. The distal poles of the gonads are at the level of

the internal inguinal ring. Complete descent of the testicles normally occurs between 315 days of gestation and the first two weeks of post-natal life. At 44 weeks, the scrotal contents are still limited to a pair of vaginal processes housing their respective gubernacula. Digital palpation of the scrotum between 150 days and full-term gestation is quite deceiving as the gubernacula are quite large and have the feeling and texture of a testicle.

Eruption of the central superior incisors was seen in all new born foals that had nursed, but not in those taken by caesarean section or autopsy of term mares.

SUMMARY

Consistently appearing developmental horizons and regular growth curves were obtained from examination of 110 aged equine embryos and fetuses. Several developmental horizons (time of appearance of eyes, eyelids, eyelid closure, eyelashes, external nares, oral opening, pinnae, pontine fissure, pontine fissure closure, first pharyngeal pouch, whiskers, mane, tail, body hair, teeth, limb buds, tail bud, ergots, vulva, prepuce, mammary gland and papillae), external body measurements (contour, crown-rump, trunk, ear, tail, forefoot, hindfoot, head length and width) and total body weight were plotted against age.

Contour, crown-rump, trunk, forefoot, hindfoot, head length and width were equally accurate aging measurements until 100 days of gestation. Beyond which time, conformation, breed and individual variations reduced the accuracy of the head and extremity measurements although contour, crown-rump and trunk measurements remained consistently valuable. Tail and ear measurements were highly variable and contribute little to accurate aging. Body weight was the least variable and thus the most valuable aging criterion throughout gestation.

The developmental horizons most valuable for aging equine embryos and fetuses include the appearance of the optic vesicles, tail and allantoic bud (20 days); eye, mouth, pontine fissure (45^{o}), fore and hindlimb buds (26 days); pontine fissure (30^{o}) and first pharyngeal pouch (28 days); lens, pontine fissure (20^{o}), genital tubercle and pinnal fold (30 days); pontine fissure closure (36 days); palpebra,

external nares and pinnae (40 days); sex character (45 days); eyelid closure (63 days) and the coronary corium (95 days).

Beyond 100 days, the external developmental changes are few except for the appearance of hair, further genital differentiation and body growth. The appearance of body, mane and tail hair can be used as an adjunct to external body measurements and weight for aging equine fetuses.

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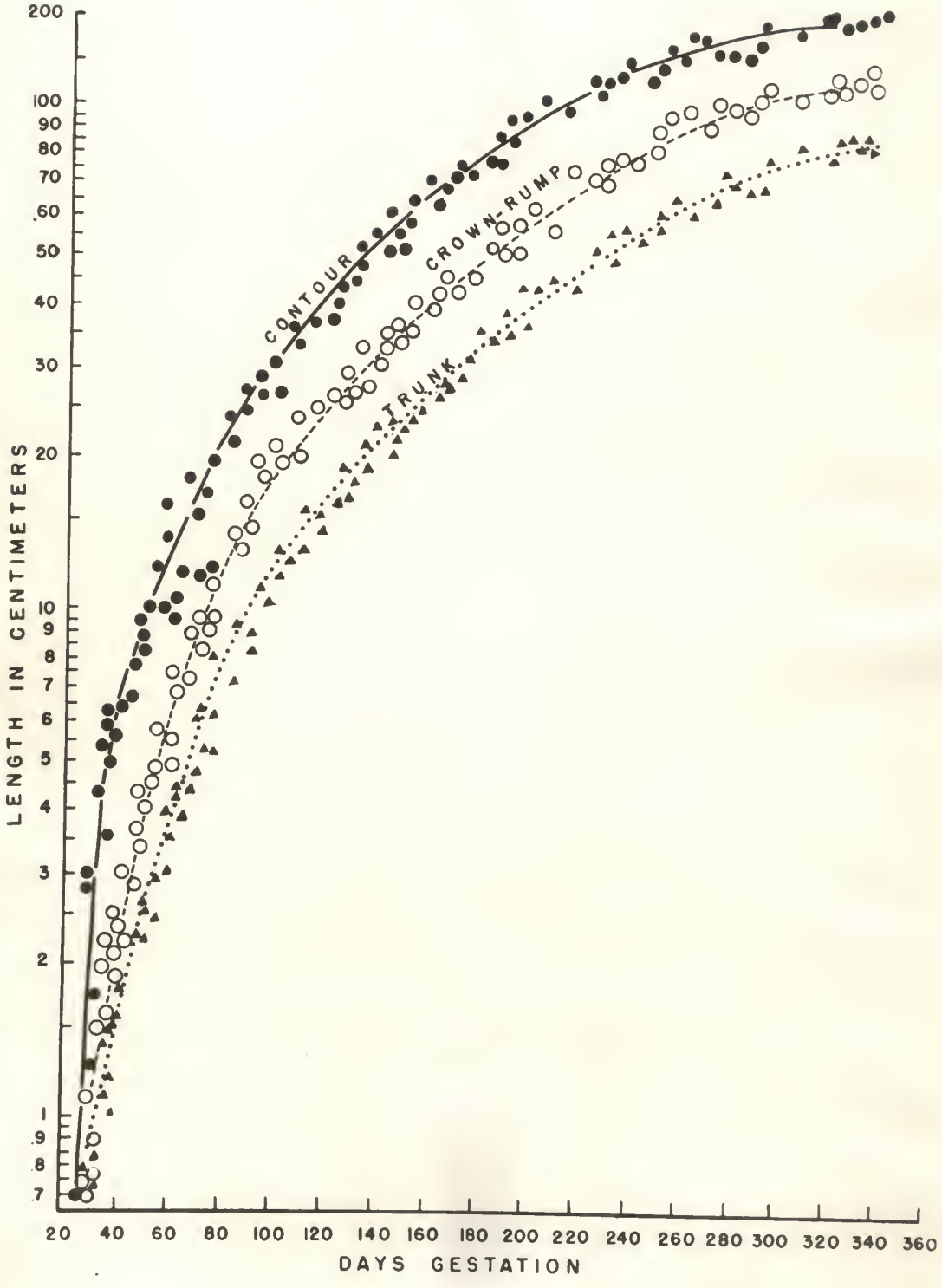
Figure 1. Contour, crown-rump and trunk measurements.

These measurements were taken from 93 fetuses collected from control-bred mares dead or euthanatized for reasons other than disease.

Contour-a body measurement remaining relatively consistent during gestation. Moderate variation occurred in the 60-80 day stage.

Crown-rump and trunk are consistently accurate criteria for aging fetuses at any stage of gestation.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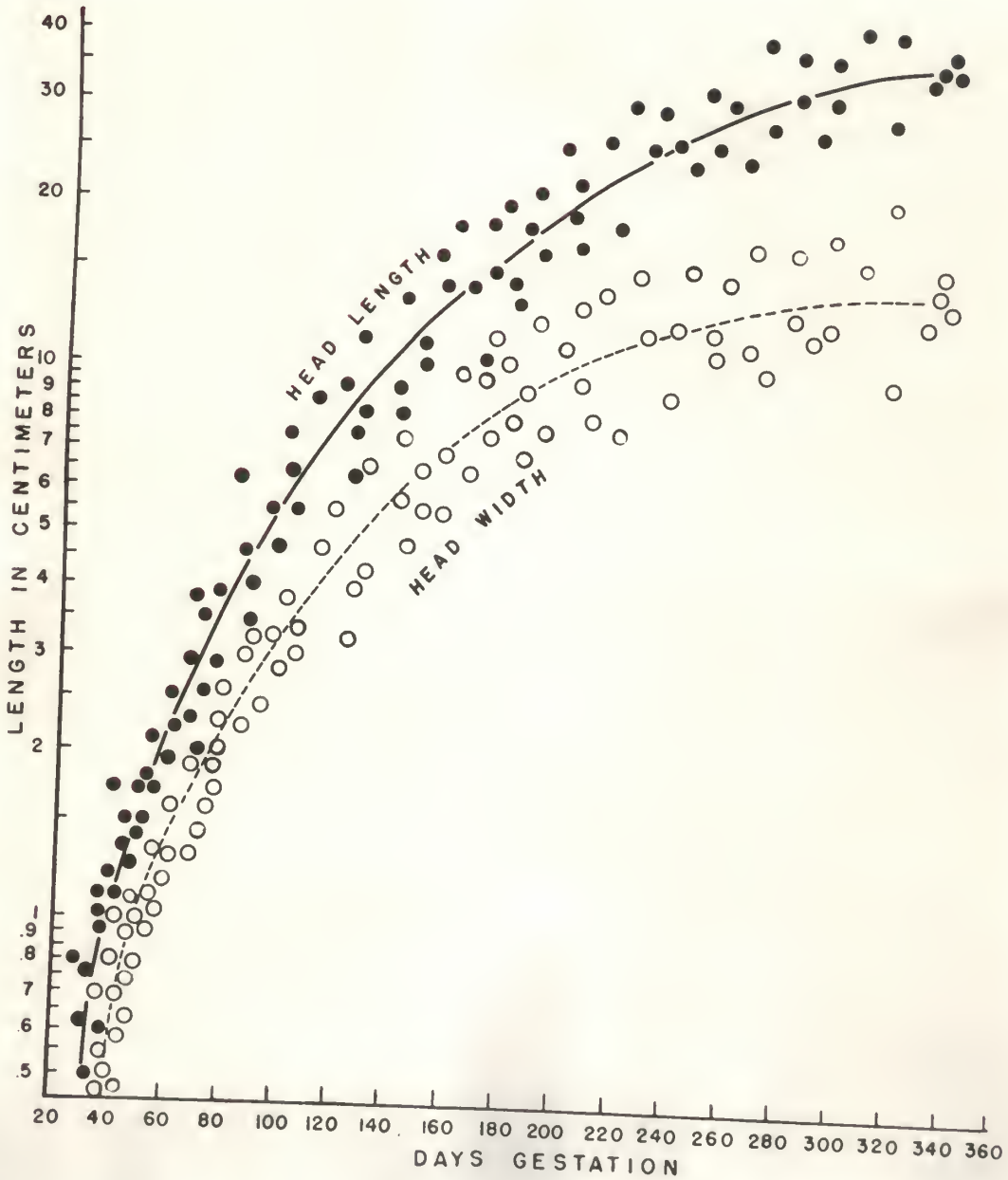
.7
CONTOUR
CROWN-RUMP
TRUNK
20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
DAYS GESTATION

Figure 2. Head Length and Width-these body measurements were also collected from 93 fetuses. These are valuable aging measurements until 80-100 days of gestation when conformational and breed variations appear.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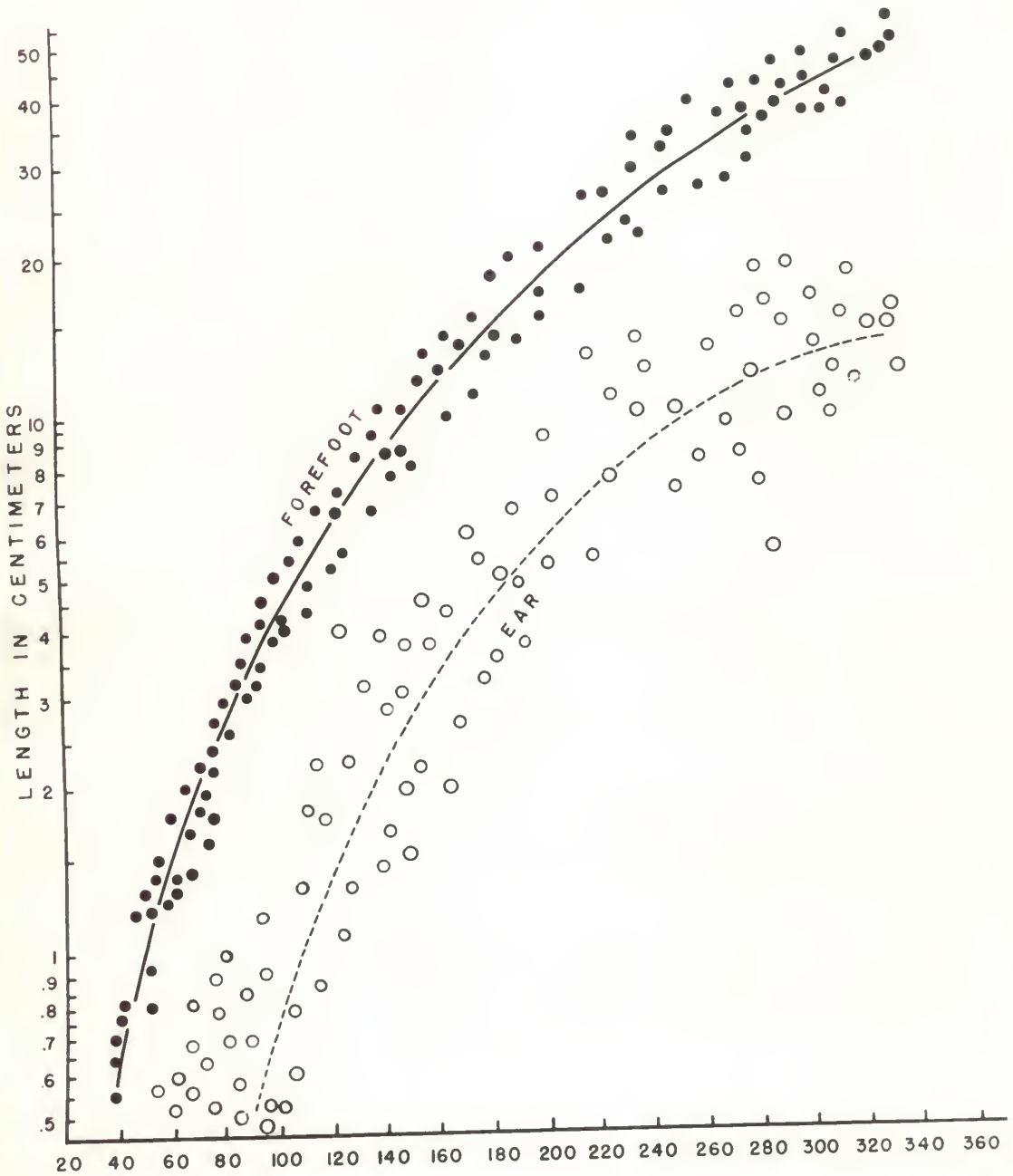
HEAD LENGTH
HEAD WIDTH
20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
DAYS GESTATION

Figure 3. Forefoot and Ear-

Forefoot, like hindfoot, was a body measurement available from 110 fetuses that were collected from mares dead or euthanatized for reasons other than disease. Forefoot again like hindfoot, is an accurate aging criterion until 100 days of gestation, beyond which time breed and conformational variations appeared.

Ear is an extremely variable body measurement throughout gestation.


LENGTH IN CENTIMETERS
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FOREFOOT
EAR
20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360

Figure 4. Hindfoot and Tail-Tail provides a moderately variable aging criterion throughout gestation, and was available from 93 fetuses.

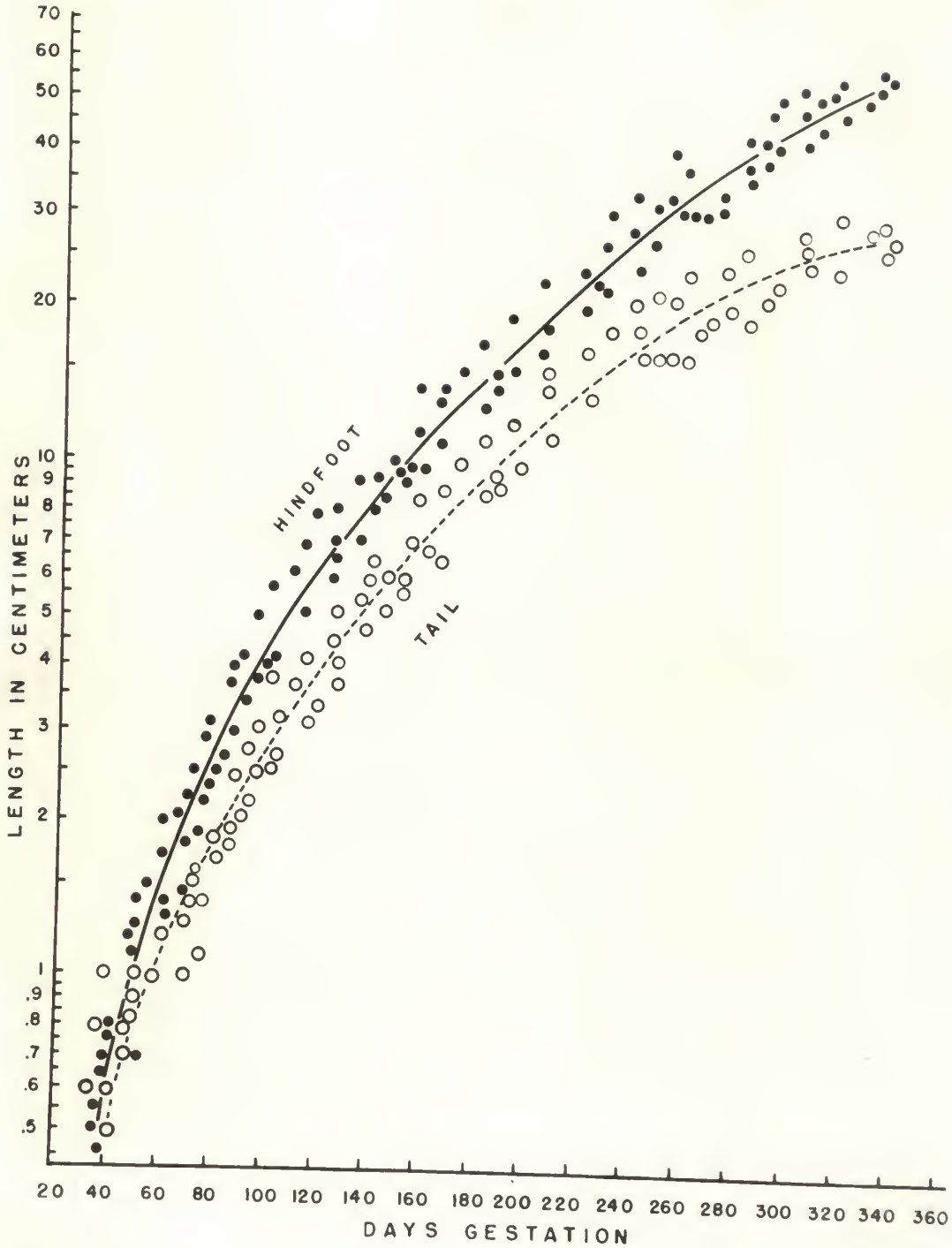

LENGTH IN CENTIMETERS
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
.9
.8
.7
.6
.5
HINDFOOT
TAIL
20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
DAYS GESTATION

Figure 5. Body Weight-this was the least variable and thus the most valuable body measurement for aging equine fetuses. Critical developmental horizons are listed in the order and stage at which they appear.

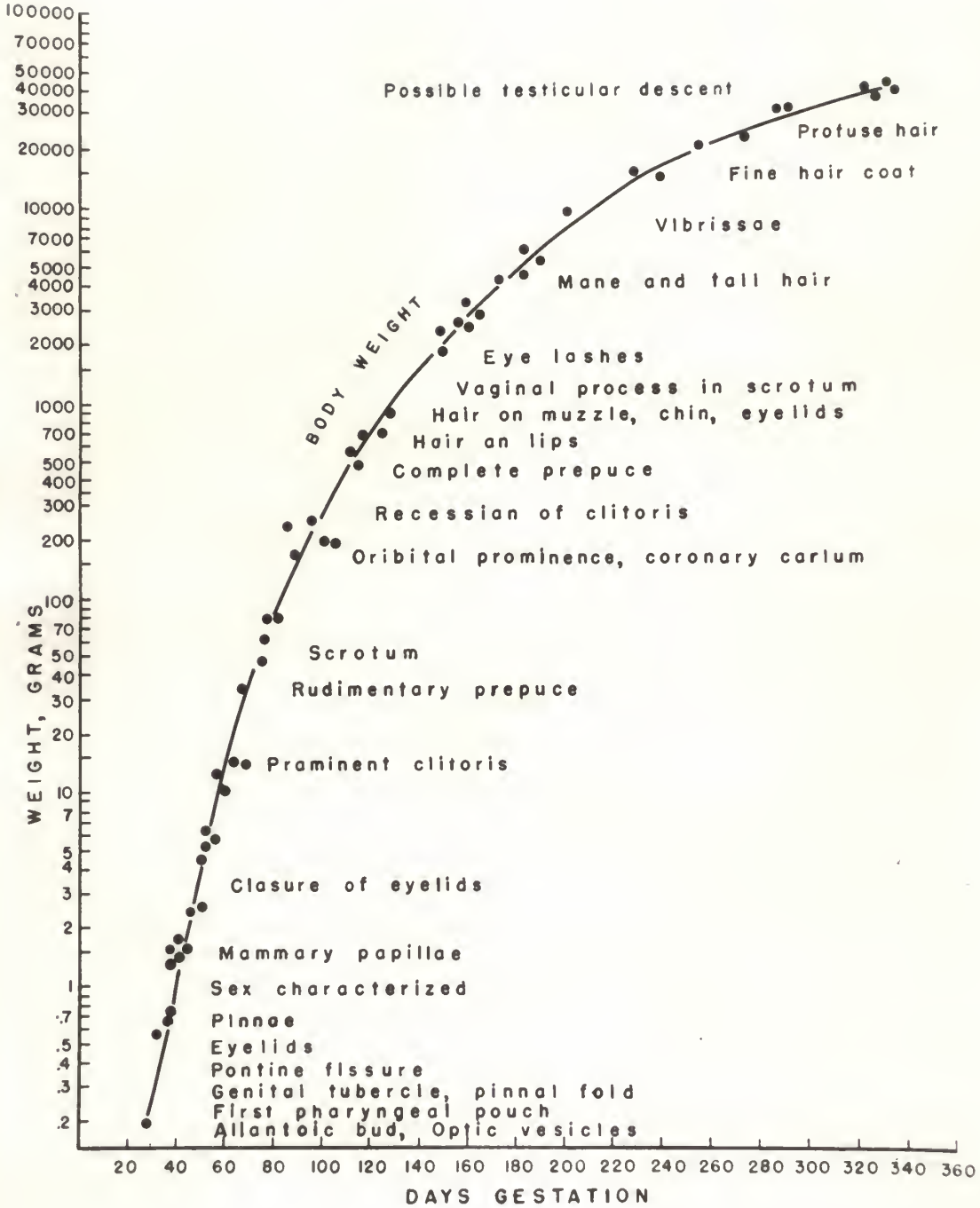

Possible testicular descent
Profuse hair
Fine hair coat
Vibrissae
Mane and tail hair
Eye lashes
Vaginal process in scrotum
Hair on muzzle, chin, eyelids
Hair on lips
Complete prepuce
Recession of clitoris
Oribital prominence, coronary carium
Scrotum
Rudimentary prepuce
Praminent clitoris
Closure of eyelids
Mammary papillae
Sex characterized
Pinnae
Eyelids
Pontine fissure
Genital tubercle, pinnal fold
First pharyngeal pouch
Allantoic bud, Optic vesicles
BODY WEIGHT
WEIGHT, GRAMS
100000
70000
50000
40000
30000
20000
10000
7000
5000
4000
3000
2000
1000
700
500
400
300
200
100
70
50
40
30
20
10
7
5
4
3
2
1
.7
.5
.4
.3
.2
20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
DAYS GESTATION

Figure 6. 20 day Equine Embryo- A heart, tail and allantoic bud can be visualized.

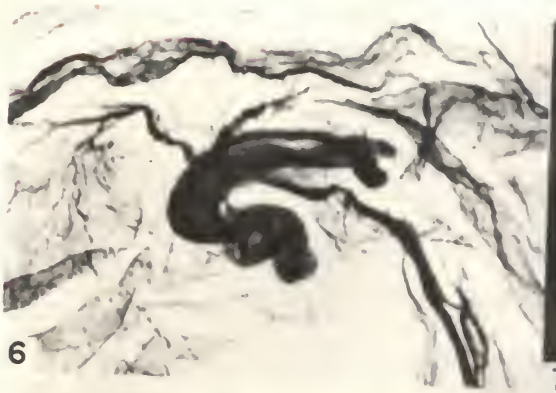
Figure 7. 26 day Equine Embryo- An eye, mouth, pontine fissure are seen along with the appearance of limb buds.

Figure 8. 30 day Equine Fetus- First phayngeal pouch (early ear) and reduced pontine fissure.

Figure 9. 35 day Equine Fetus- Nose, pontine fissure closed.

Figure 10. 40 day Equine Fetus- Eyelids and pinnae have appeared.

Figure 11. 55 day Equine Fetus- Partial closure of the eyelids, and lips, nostril and early feet may be visualized.



6

7

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11

Figure 12. 75 day Equine Fetus- Eyelids closed, prominent clitoris.

Figure 13. 95 day Equine Fetus- Conformational characteristics present.

Figure 14. 120 day Equine Fetus- Ergots and orbital areas prominent.

Figure 15. 150 day Equine Fetus- Completely hairless at this stage.

Figure 16. 210 day Equine Fetus- Hair on muzzle, chin, eyelids, mane and tail.

Figure 17. Term Foal- A complete hair coat that is profuse and shabby. Note keratogenous pads on hoofs.


12
14


52 T8
13
15


16


17

DEVELOPMENTAL HORIZONS AND MEASUREMENTS USEFUL FOR AGE DETERMINATION OF EQUINE EMBRYOS AND FETUSES

by

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AN ABSTRACT OF A MASTER'S THESIS

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Consistently appearing development horizons and regular growth curves were obtained from examination of 110 aged equine embryos and fetuses.

Contour, crown-rump, trunk, forefoot, hindfoot, head length and width were equally accurate aging measurements until 100 days of gestation. Beyond which time, conformation, breed and individual variations reduced the accuracy of the head and extremity measurements although contour, crown-rump and trunk measurements remained consistently valuable. Tail and ear measurements were highly variable and contribute little to accurate aging. Body weight was the least variable and thus the most valuable aging criterion throughout gestation.

The developmental horizons most valuable for aging equine embryos and fetuses include the appearance of the optic vesicles, tail and allantoic bud (20 days); eye, mouth, pontine fissure (45^{o}), fore and hindlimb buds (26 days); pontine fissure (30^{o}) and first pharyngeal pouch (28 days); lens, pontine fissure (20^{o}), genital tubercle and pinnal fold (30 days); pontine fissure closure (36 days); palpebra, external nares and pinnae (40 days); sex character (45 days); eyelid closure (63 days) and the coronary corium (95 days).

Beyond 100 days, the external developmental changes are few except for the appearance of hair, further genital differentiation and body growth. The appearance of body, mane and tail hair can be used as an adjunct to external body measurements and weight for aging equine fetuses.