II. REVIEW OF LITERATURE

General

The classical stages of canine estrous cycle introduced by Heape (1900) were proestrus, estrus, metestrus and anestrus. In recent years, metestrus has been largely replaced by the term diestrus (Olson and Nett, 1986). Proestrus clinically begins with vulval swelling and onset of blood tinged vaginal discharge (Goodman, 1998). Behaviorally, the bitch will attract male but refuse to let him to mount (Olson and Nett, 1986; Goodman, 1998). The average duration of proestrus in mature bitches is stated to be 9 days, ranging from 0 to 27 days (Bell and Christie, 1971; Olson and Nett, 1986; Concannon, 1987; Allen and England, 1990).

Endocrinologically, proestrus is characterized by a rising serum concentration of estradiol which peaks one to two days before the end of the proestrus and decline when the acceptance of the male is first observed (Bell et al., 1971; Concannon et al., 1975; Edquist et al., 1975; Nett et al., 1975a; Wildt et al., 1970; Olson et al., 1982; Goodman, 1998). Serum concentration of progesterone (P₄) remained at basal level (<1ng/ml) prior to and during first few days of proestrus followed by gradual increase. This increase was related to preovulatory lutenization of follicles (Phemister et al., 1973; Concannon et al., 1977c). Serum concentration of luteinizing hormone (LH) remained at baseline during most of its proestrus (Olson and Nett, 1986).

Proestrus proceeds into estrus, which is the stage of the cycle characterized by the bitch’s acceptance of the male for mating. The first day the bitch allows mating (standing estrus) is considered as the start of estrus and this phase ends when she no longer accepts
the male (Feldman and Nelson, 1996). Bell and Christie (1971) reported the average
duration of estrus, based on the behavioral signs of estrus as 9 days, ranging from 4 to 24
days. Feldman and Nelson,(1996) stated that the duration of estrus is usually 5 to 9 days,
but may vary dramatically among normal dogs being as brief as 1 to 2 days or as
prolonged as 18 to 20 days.

Endocrinologically, estrus begins with the lutenizing hormone(LH) surge and is
characterized by rising progesterone and declining estrogen levels (Goodman, 1998). The
bitch appears to become receptive to male after the serum concentration of progesterone
begins to rise (Concannon et al., 1975; Concannon et al., 1979; Beach et al.,1982).
Although estrogen alone can induce female sexual behavior, progesterone seems to
further enhance and synchronize this behavior (Leedy, 1988). The decline in serum
concentration of estradiol proceeds and may influence the LH surge that occurs near the
onset of estrus and leads to ovulation (Concannon et al., 1979).

Some investigations have reported that preovulatory LH surge occurred on the
first day of standing estrus (Reimers et al., 1978). In some bitches, the onset of
behavioral estrus was found to occur as early as 2-3 days before LH surge, while in many
others, it didn’t occur until 4 to 5 days after LH surge. Concannon (1987) stated that in
some cases, an aggressive male might mate a bitch in late proestrus as early as 4 to 5 days
before the LH surge, while some bitches may refuse to be mated until more than 6 days
after the LH surge.

The duration of the preovulatory LH surge in the bitch appears to vary with a
range of 24 to 96 hrs (Smith and McDonald, 1971; Nett et al., 1975; Concannon et al.,
1977c; Reimers et al., 1978; Wildt et al., 1978 and Olson et al., 1983). Ovulation occurred approximately 2 to 3 days following the preovulatory LH surge (Phemister et al., 1973; Concannon et al., 1977c; Wildt et al., 1978; Tsutsui, 1989). The average interval from LH surge to ovulation was reported as 2 days in 10 Beagle bitches (Phemister et al., 1973).

Canine oocytes are ovulated as primary oocytes and after ovulation they undergo first meiotic division to become secondary oocytes (Concannon et al., 1977c; Olson and Nett, 1986; Tsutsui, 1989; Johnston et al., 2001). Once the maturation is complete, the viable life span of secondary oocytes is stated to be approximately only 2 to 3 days (Tsutsui, 1989; Concannon et al., 1989; Linde, 1991). However, the spermatozoan longevity in the female genital tract is reported to extend from 5 to 11 days (Doak et al., 1967; Holst and Phemister, 1971; Holst and Phemister, 1974; Concannon et al., 1983). This extended longevity of spermatozoa in canine allows breeding that occur considerably before fertile period to still produce progeny (Goodman, 2001).

2.0. Duration of pregnancy

Duration of gestation in the bitches has been reported using the following criteria.

a) The interval between a single or first of the multiple matings to the day of parturition.

b) Interval from luteinizing Hormone (LH) surge to parturition and

c) Interval from preovulatory rise in serum progesterone concentration to parturition.
2.1. The interval between a single or first of the multiple matings to the day of parturition

Gestation length in dog, expressed as the interval from an initial or a single mating to parturition is reported to average 64 to 66 days (Anderson, 1970; Holst and Phemister, 1971; Anderson and Simpson, 1973; Holst and Phemister, 1974; Concannon et al., 1975; Sokolowski, 1980). However, the range in gestation length may be considerable. Normal pregnancies as short as 57 days and as long as 68 days have been reported after single matings (Holst and Phemister, 1974). In one colony, gestation lengths of 57 to 72 days were encountered after the first of multiple matings and 52 to 70 days after single matings (Concannon and Rendano, 1983). Concannon et al. (1983) studied the variation in canine gestation length of 290 beagle bitches and reported that the apparent gestation length estimated at the interval from day of first mating to the day of parturition ranged from 57 to 72 days and averaged 65.3 ± 0.2 days. Wildt et al. (1970) opined that a gestation length beyond 70 days after the single mating was probably pathological. The wide variation reported in the gestation length of the dog, when calculated as the interval from initial or a single mating to parturition has been attributed to be due to the variations in the time of mating in relation to the time of fertilization (Concannon et al., 1983).

2.2. Interval from luteinizing hormone (LH) surge to parturition

As the behavioral estrus and the first acceptance of the male are not well correlated with the time of LH surge/ovulation/fertilization, many researchers have attempted to establish the duration of pregnancy as the interval from LH surge to the time
of parturition. In the reports of Concannon et al. (1983), the interval from the day of peak concentration of serum LH to parturition was less variable, and ranged from 64 to 66 days and averaged 65.1 ± 0.1 days. Apparent gestation length of less than 61 days resulted from matings carried out on three or more days after LH peak. Parturition occurring six or more days after the predicted day of parturition (64 to 66 days) were attributed to initial or single matings recommended two or more days before LH peak. It was also stated that fertile mating 3 days before LH peak provided evidence that the potential postcoital longevity of canine sperm was at least 6 days. It was concluded that the limited range in the interval from the day of preovulatory LH peak to the day of parturition demonstrated a considerable regularity in the sequential events of gestation length in the dog (Kutzler et al., 2003).

2.3. Interval from preovulatory rise in serum progesterone (P₄) concentration to parturition

Prediction of the duration of pregnancy on the basis of LH surge is difficult for a practicing clinician as identification of LH surge require frequent sampling of the blood, sophisticated laboratory facilities, besides being cost effective. Therefore, recommendations have been made for identifications of time of LH surge on the basis of changes in the serum concentration of progesterone (P₄) during late proestrus and estrus(Concannon et al.,1977a;1977b;Nett et al.,1975).Goodman (1998), opined that if accurate serial quantitative serum P₄ concentrations are obtained, the LH surge might be estimated as the day when a distinct rise in levels of serum P₄ is seen and that fertile matings should result in whelping 64 to 66 days later. Concannon et al. (1983) demonstrated that the changes in the serum P₄ concentrations during the later part of
proestrus and early estrus was characterized by a gradual increase with a sudden sharp rise which coincided with the LH surge. Basal serum P₄ levels have been reported to typically range between 0 to 1 ng/ml during an estrus and proestrus (Concannon et al., 1977a:1977b). At the time of LH surge, serum P₄ concentration rose rapidly (0.8 to 3 ng/ml), continued to rise at ovulation (1.02 to 8.0 ng/ml), and was even higher (4.02 to 20 ng/ml) towards the end of fertile period (Concannon, 1986; Jeffcoate and Lindsey, 1989).

Bouchard et al. (1991) stated that ovulation was estimated to occur when serum P₄ concentration was 4.9 ± 1.0 ng/ml (3.4 to 6.6 ng/ml). Wright (1990), reported that LH surge was located to the period when serum P₄ concentrations were between 2 to 4 ng/ml and that ovulation occurred when the serum P₄ concentrations was 5.4 ng/ml (range 3 to 8 ng/ml). Renton et al. (1991) reported that in bitches, the concentrations of serum P₄ reached 3 ng/ml two days before ovulation, and recommended the determination of serum P₄ concentration for identifying the time of ovulations. In another study carried out to compare the endocrine changes and ultrasound as means of identifying the ovulation in the bitch. Renton et al. (1992) reported that serum P₄ concentrations were around 3 ng/ml on the day of LH surge in 12 out of 20 bitches and within 1 day in 7 out of 8 bitches. Ultrasound was less accurate in that, only 4 of the 16 estimates agreed. It was concluded that the measurements of serum P₄ concentration was a better indicator for ovulation than ultrasonography.

Zoldog et al. (1994) reported that ovulation in bitches occurred when serum P₄ concentration reached 5 ng/ml. Barr (1995) reported that in all 14 beagle bitches studied,
the serum $p_4$ concentration was high, ranging from 1.9 to 11.7 ng/ml around the time of ovulation. Johnston and Root (1995) in a retrospective study of 49 bitches reported that serum $P_4$ concentrations began to rise concurrently with LH surge, reaching 1.0 to 1.9 ng/ml; on the day of LH surge. The day after LH surge, the serum $P_4$ concentration was 2 to 9 ng/ml. On the day of ovulation, the serum $P_4$ concentration measured 4.0 to 10ng/ml.

2.4. Prediction of parturition date

The methods for prediction of parturition date in bitches suggested include

1. Prediction of parturition date on the basis of initial distinct rise in preovulatory serum $P_4$ concentrations.

2. Prediction of parturition date on the basis of ultrasonographic measurements of the gestational sac or fetal head diameter.

3. Prediction of parturition date on the basis of behavioral and physical changes in the pregnant bitch.

4. Prediction of parturition date by monitoring the changes in the rectal temperature during the later stages of the pregnancy.

2.4.1. Prediction of parturition date on the basis of initial distinct rise in preovulatory serum $P_4$ concentrations.

Wright (1990) reported the mean whelping day in 11 bitches as 62 days after the time of ovulation. The time of ovulation was determined on the basis of serum progesterone concentrations.
Okkens *et al.* (1993) reported the mean length of gestation in 77 dogs of different breeds as estimated by calculating the interval from matings recommended on the basis of preovulatory serum P₄ concentration to parturition as 62.1±0.2 days, with a variation of 11 days. The duration of gestation in 103 bitches mated on the basis of serum P₄ concentrations were reported by Okkens *et al.* (2001) as 61.4 ±1.5 days with a range of 58 to 65 days.

Kang *et al.* (1997) determined the duration of pregnancy in 5 Maltese and 3 Yorkshire bitches. Day of pregnancy was estimated to occur when serum P₄ concentration increased above 4ng/ml. The mean duration of pregnancy was 61.5 days with a range of 60 to 64 days.

Suyesh (2002) reported the gestation length in relation to serum concentrations of P₄ at the time of matings in 22 bitches. When the serum concentration of P₄ ranged between 1 to 2 ng/ml and the bitches were recommended to be bred, delivery occurred at an average of 62 ± 1 days from the day of first mating. When the serum P₄ concentration was more than 2 ng/ml at the time of recommendation of mating, the mean gestational length was 61.71 ± 0.66 Days.

Kutzler *et al.* (2003) attempted to predict the date of parturition from the initial rise in preovulatory serum P₄ concentration in 63 bitches belonging to 19 different breeds. The day of preovulatory rise in serum P₄ was defined as the day when serum P₄ concentration rose to more than 1.5ng/ml and was at least twice the baseline concentration. The predicted parturition date, 65 days following the day of preovulatory rise in serum P₄ was compared to actual parturition day. The mean serum P₄ concentration
was determined as $2.02 \pm 0.18$ng/ml. In addition, the accuracy of prediction of parturition date within $\pm 1$, $\pm 2$ and $\pm 3$ day using prebreeding serum $P_4$ concentrations was 67, 90, and 100 percent respectively. Further, the accuracy of the predicting the date of parturition was not affected by the litter size.

Venkatachalapathy (2005) recommended matings in 21 bitches on the day when the serum $P_4$ concentration reached a minimum of 4ng/ml and reported the gestation period in these bitches to range from 58 to 66 days with an average of 62.01 $\pm$0.46 days. Seventy five percent of the pregnant bitches delivered before the 64th day and it was concluded that serum $P_4$ concentration higher than 4ng/ml was more closely related to the time of ovulation than the time of LH surge.

Tsutsui et al. (2006) studied the relationship between the ovulation and duration of gestation in dogs. The day of ovulation was estimated as the first day when the serum $P_4$ concentration exceeded 2ng/ml. Gestation length was calculated as the interval from the estimated day of ovulation to the day of parturition. The mean intervals from mating to parturition in bitches mated 1 to 5 days after ovulation were 63.4$\pm$0.6, 61.6$\pm$0.7, 60.8$\pm$0.7, and 59.7$\pm$0.6 and 59.1$\pm$0.3 days respectively. The gestation length (interval from estimated day of ovulation to parturition) ranged from 61 to 66 days with an average of 63.9$\pm$0.2 days.

Kim and Son (2007) estimated the duration of gestational age in 9 Miniature Schnauzer bitches to range from 61 to 65 days with a mean of 63.0$\pm$1.7 days when matings were recommended on the day when the serum $P_4$ concentration was in excess of 4ng/ml.
2.4.2. **Prediction of parturition date on the basis of ultrasonographic measurements of the gestational sac or fetal head diameter.**

Real time ultrasonography has proven to be a valuable tool for diagnosing canine pregnancy and assessing fetal viability (Inaba *et al.*, 1984). Alitalio (1983) reported that the fetal heart beat was detected on 28th day of gestation with the use of real time ultrasound in the bitch. Cartee and Rowlers (1984) reported that ultrasonographically, the embryo in bitch was identifiable at day 10 following LH surge. Fetal and cardiac activities could be monitored at day 28 of gestation. Similarly, Shille and Gontarek (1985) reported that viability of the fetus can be judged by the presence of fetal movements after day 28 of gestation. Concannon (1986) stated that real time ultrasound scanning allows direct visualization of vesicles and or fetal movements and provided the ability to perform pregnancy diagnosis through the post implantation period. The ultrasonographic appearance of a gravid uterus in Beagle bitches at known times of gestation was studied in detail by Yeager and Concannon (1990) and Yeager *et al.* (1992). They detected cardiac activity and fetal movements as early as 25 and 34 days, respectively after LH surge. Mattoon and Nyland (1995) reported that detection of gestational sac at 20 days post breeding was the first sign of confirming pregnancy using ultrasonography, but preferred to wait until day 30 following last mating as gestational sac with viable embryo could be identified with high level of confidence at that time.

Shille and Gontarek (1985) reported the average diameter of the gestational vesicle as determined by ultrasound in 23 Grey Hound bitches. Pregnancy was timed from the calculated date of ovulation to the day when first pup was born. The study reported that the gestational sac diameter increased as gestation progressed. On days 27
to 34, 35 to 44 and 47 to 56 after ovulation, average vesicle diameter ranged between 23 to 30mm, 25 to 49mm and 46 to 89 mm respectively, with mean diameter of 26.5mm, 36.1mm and 68.3mm respectively.

England et al. (1990) attempted to determine the gestational age in 50 clinically normal bitches. Ultrasonographic measurements were made on three occasions (early, mid and late pregnancy) and were related to the date of parturition. The study revealed that the diameter of spherical conceptuses during early pregnancy was significantly related to gestational age. The study also showed that in bitches of similar size, the measurement of conceptus diameter, biparietal diameter and trunk diameter were closely related to gestational age.

Yeager et al. (1992) used ultrasonography to estimate the gestational age in 8 pregnant Beagle bitches. The gestational age was based on the day of preovulatory LH surge which was denoted as “0”day of gestation. Serial ultrasonographic examinations of each pregnant bitch began on day 28 to 37 after the LH surge. It was reported that measurements of chorionic cavity diameter was the most accurate predictor of gestational age. It had the least variation compared with all other measurements on the fetus. From days 38 to 60, fetal head diameter was the more accurate predictor of gestational age.

Valocky et al. (1997) opined that best predictors of gestation age in early to mid pregnancy were chorionic cavity diameter (CD) and uterine lumen diameter. They also opined that gestational age is best predicted from day 35 to term with measurements of biparietal diameter and head diameter.
A study was undertaken by Luvoni and Grioni (2000) to estimate the gestational age in medium size dogs by ultrasonographic examinations. Formulae were derived to estimate the expected date of delivery by measuring the anatomical fetal structures. The diameter of the gestational sac was determined to be 90.9 percent accurate and that of biparietal diameter 70.8 percent accurate for predicting the date of parturition to within ±1 day in medium size dogs. The accuracy of prediction of date of parturition for small size dogs was 90.9 percent using gestational sac diameter and 68.2 percent using biparietal diameter.

Son et al. (2001) stated that the ultrasonographic measurements of inner chorionic cavity diameter on days 18 to 37 and fetal head diameter on day 38 to parturition showed the best correlation to gestational age and prediction of parturition date.

Kutzler et al. (2003a) carried out a retrospective study on fetal measurements obtained by transabdominal ultrasonography of 83 bitches (32 breeds) to estimate the gestational age using two published tables correlating embryonic vesicle diameter, crown-rump length, body diameter and biparietal diameter to the LH surge in mid gestational Beagles. Parturition was predicted by obtaining the difference between, the gestational age estimate and 65 days. Bitches were divided into four body weight groups based on their non pregnant body weight: small (<9 kg), medium (>9 to 20 kg), large (>20 to 40 kg), and giant (>40 kg). Litter size was obtained for each group. The body weight groups were then divided into small, average, or large litter size groups. The accuracy of the prediction was not affected by litter size, but was affected by maternal body weight for small and giant body weight groups only. When adjusted for weight, the
accuracy of prediction within ±1 day and ±2 day intervals was 75 and 87 percent, respectively. Parturition date predictions made after 39 days of gestation using only biparietal and body diameter were less than 50 percent accurate within ± 2 days.

Beccaglia and Luvoni (2006) studied the accuracy of ultrasonographic measurements and suggested that inner chorionic cavity diameter and biparietal diameter were equally reliable parameters in obtaining a reasonably accurate prediction of parturition date at any gestation period at which a bitch was examined.

Lenard et al. (2007) assessed the accuracy of estimating the gestational age and litter size prediction in 76 bitches using one of two techniques. The first method used the differential features of fetal organ development that occur in early and mid pregnancy, based on published tables for Beagles. The second method used biparietal head and trunk diameters to predict gestational age based on tables published for late gestational Labrador Retrievers. The accuracy of the two methods was compared to evaluate the effect of maternal body weight and litter size. Litter size and maternal body weight did not affect the accuracy of gestational age prediction. Using a combination of both methods, the overall accuracy of predicting parturition date to within 65 ± 1 day and ± 2 days was 70.8 percent and 86.1 percent, respectively. The correct litter size was predicted in 65 percent of cases, and in 89.5 percent of cases for ± 1 pup. It was concluded that the optimum time for sonographic estimation of fetal age and litter size was in early and mid pregnancy.
2.4.2.1. Estimation of litter size on the basis of ultrasonographic measurements of the gestational sac/fetus.

Shille and Gontarek (1985) reported that estimation of fetal numbers by ultrasound was not reliable when the litter size was more than four.

Toal et al. (1986) reported that ultrasound was only 36 percent accurate for fetus counting, but was still superior to palpation, which was only 12 percent accurate in estimating litter size.

In the studies of England and Allen (1990), the accuracy of counting conceptuses at 28 to 30 days after the calculated LH peak was poor. The number was accurately determined using a B mode ultrasound in only 31.8 percent of pregnancies. The greatest tendency was to underestimate. Twenty percent of the inaccuracies were due to overestimation. Further; the accuracy was less for large litters. The mean difference between the estimated number and the actual number of pups born was 1.0±1.7.

England (1995) reported that the accuracy of estimating absolute fetal number were poor. Recently England (1992) suggested that, for the bitch, the greatest accuracy was before day 30 after the LH surge, when 38 percent of examinations were successful in predicting fetal numbers. Generally, the numbers of fetuses were underestimated, the error being associated with overlooking fetuses, or mistaking them as already counted or due to acoustic artifacts. He also classified bitches as having either five pups or more or four pups or fewer, and found the efficiency of prediction to be 97 percent. The accuracy of predicting actual fetal number was low in later pregnancy (Shille and Gontarek, 1985; England and Allen, 1990). For examinations between 30 and 50 days of pregnancy
England (1992) found the accuracy to be 18 percent and after 50 days of pregnancy to be 8 percent.

The accuracy of estimation of litter size using ultrasonography was reported to be between 81.8 percent and 100 percent. (Valocky et al., 1997a)

Lenard et al. (2007) assessed the accuracy of gestational age and litter size predictions in 76 bitches using ultrasonography. The correct litter size was predicted in 65 percent of cases, and in 89.5 percent of cases for ± 1 pup. The optimum time for sonographic estimation of fetal age and litter size were early and mid pregnancy.

2.4.3 Prediction of parturition date on the basis of behavioral and physical changes in the pregnant bitch.

The behavioral and physical changes considered for predicting impending parturition in bitch include mammary development, lactation, nesting behavior, panting, vulval relaxation and vaginal discharges (Holst and Phemister, 1974; Concannon et al., 1977a; Concannon et al., 1977a:1977c; Rendano et al., 1984; Roberts, 1986; Roberts, 1986a; Sherwood, 1988; England and Allen (1990). Concannon et al. (1989) observed obsessive nesting behavior shortly before birth of the first pup. The onset of secretions of milk by the bitch is reported to be observed from two weeks before to until several days after parturition (Roberts, 1986a). Colostrum appeared yellow tinge and more opaque than later milk (Roberts, 1986). Johnston et al. (2001) stated that the onset of nesting behavior in pregnant bitches can be observed as early as 5 to 7 days earlier to parturition. The vagino vestibular junction and vulva also has been stated to relax prior to parturition.
Long *et al.* (1978) reported that, the most consistent and reliable physical sign of impending parturition in pregnant Beagle bitches was palpable relaxation of pelvic and abdominal musculature. Abrupt changes in attitude or appetite were the chief behavioral changes observed.

Buckner (1979) reported that the appearance of milk in the teat canals was extremely variable and that it may appear several days to hours prior to visible labor or concurrently with whelping.

Concannon (1986) described the impending signs of parturition in detail. Bitches usually became restless two to three days prior to parturition and reduced food intake. There was an increased restlessness, panting, scratching, chewing and nesting behavior 12 to 24 hours prior to parturition.

Moiser (1986) stated that signs of prepartum behaviors are characterized by dams anxiety, restlessness and intermittent nest making. Milk may be present as early as seven days in mammary glands of multiparous, while in primipara, it could be present just prior to the time of parturition.

Johnston *et al.* (1988) stated that presence or absence of the vaginal discharges cannot be taken as a reliable signs for predicting the parturition date as it is not only misleading, but it is also usually incorrect.

Restlessness, panting, chewing and scratching of bedding materials were described as signs of impending parturition in bitch by Wallace and Davidson (1995).
Concannon (2000) reported that prepartum behavior of nesting, digging, social withdrawal and differentialness coincided with the corresponding rectal drop of rectal temperature by 1°C or more pre partum.

2.4.4 Prediction of parturition date by monitoring the changes in the rectal temperature during the later stages of the pregnancy.

The prepartum drop in rectal temperature has been stated in many reports as a particularly useful clinical tool, in predicting onset of whelping, because it is a clinical indicator of the rapid decline in serum progesterone, the thermogenic hormone that maintains pregnancy, at the end of gestation (Johnston et al., 2001). The average rectal temperature was reported to decline gradually in pregnant Beagle bitches during late diestrus (Holst, 1985). A transient and abrupt prepartum temperature drop occurred in 78 of 80 pregnancies, in which rectal temperatures were recorded daily or more frequently (Concannon et al., 1977). Mean low temperature recorded for 40 pregnancies between 8 to 24 hours prior to parturition was 98.8°F (Range 98.1 to 100°F). Rectal temperature subsequently increased at parturition and was above those recorded during the prepartum period for at least 4 days post partum. Rectal temperature declined abruptly, at least one full degree and often to less than 99°F, about 14 hours after prepartum luteolysis with drop in serum P₄ to less than 1ng/ml. Rectal temperatures thereafter began to rise as the bitch entered the first stage of labor, and whelping started 8 to 24 hours after the temperature drop (Concannon et al., 1977).

Long et al. (1978) reported that a drop in rectal temperature was of some value but was found to be too variable between individuals to use as the sole criterion.
Concannon (2000) stated that, there was a concurrent pre-partum decline in body temperature which was most readily observed with twice daily or more frequent rectal temperature measurements started several days before parturition.

Johnston et al. (2001) suggested that, the owners should be instructed to monitor rectal temperature of the gravid bitch, starting 54 to 55 days following breeding, if prediction of onset of whelping is desired. It was recommended that the rectal temperature should be obtained daily in a constant manner. It was stated that small temperature drop may be observed during the last week of pregnancy and the considerable variation in rectal temperature values may occur between breeds. It was also stated that some bitches may not demonstrate a detectable prepartum rectal temperature drop even when monitored three times daily.

The results of the study by Veronesi et al. (2002) suggested that changes in the body temperature could not predict impending parturition in the bitch.