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Control of equine parturition in a Hungarian Thoroughbred farm

Diploma work

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Abstract

The primary goal of our work was to investigate the situation of Thoroughbred breeding based on data obtained in a Hungarian Thoroughbred Farm, with particular regard to the breeding processes, its regulation, manipulation, and the period of pregnancy, as well as the factors surrounding foaling. We collected information and data about the covering and foaling seasons of the last six to seven years (2017-2023), which we recorded in digital form since they were only available in the form of handwritten notes. Approximately 260 broodmares and their offspring, 160 foals, were analysed in the research. The paper revealed that the conception rate of these mares requires further research and development, as it is estimated to be approximately 64%. The number of unwanted factors surrounding foalings, such as dystocia, stillbirth, and weak- and dead foals, was low, moreover, only 8% of the cases had a fatal outcome. Even better results can be achieved by preventing the possible errors mentioned in the thesis. Overall, it can be concluded that the research proved useful from several points of view, highlighting that this is the first comprehensive study of the stud between 2017 and 2023 documented in electronic form. Based on the results, the development of Thoroughbred breeding management is justified and feasible from both research and an economic point of view, the possibilities of which are covered in the thesis, but further studies are necessary for more accurate data, statistics, and proposals.

A munkánk elsődleges célja az volt, hogy megvizsgáljuk a Telivér tenyésztés helyzetét egy Magyarországi telivér tenyészetben szerzett adatok alapján, különös tekintettel a tenyésztési folyamatokra, annak szabályozására és a vemhesség időszakára, valamint az ellés körüli tényezőkre. Információkat és adatokat gyűjtöttünk az elmúlt hat-hét év (2017-2023) fedeztetési- és ellési idényeiről, amelyeket digitális formában rögzítettünk, hiszen ezek csak kézzel írt jegyzetek formájában álltak rendelkezésre. A kutatásban körülbelül 260 tenyészkanca és ezek szaporulata, 160 csikó került elemzésre. A dolgozat feltárta, hogy ezeknek a kancáknak a fogamzási aránya további kutatást és fejlesztést igényel, mivel ez a becsléseink szerint megközelítőleg 64% volt. Az ellés körüli nem kívánt tényezők száma, például nehézellés, halva születés, élet gyenge és elhullott csikók aránya alacsonynak bizonyult, mindösszesen 8% volt. A dolgozatban említett esetleges hibák megelőzésével még ennél is jobb eredmények érhetők el. Összességében elmondható, hogy a kutatás több szempontból is hasznosnak bizonyult, kiemelve azt, hogy ez az első elektronikus formában is dokumentált összesítő vizsgálat a ménesről 2017 és 2023 közötti időszakban. Az eredmények alapján a tenyésztési eljárások fejlesztése mind kutatási, mind pedig gazdasági szempontból is indokolt és megvalósítható, melyek lehetőségeire a dolgozat is felhívja a figyelmet, viszont további vizsgálatok szükségesek a még pontosabb adatok, statisztikák, valamint javaslatok feltárása érdekében.

1. Table of contents

1. Table of contents 2
2. List of abbreviations 4
3. Introduction and Goals 5
4. Literature review 6
4.1. Manipulation of the oestrus cycle 6
4.1.2. Artificial illumination 6
4.13. Induction of ovulation 7
4.1.4. Shortening the cycle via inducing luteolysis 7
4.1.5. Feeding of gestagens 8
4.2. Breeding soundness examination of the mare 8
4.3. Covering 11
4.4. Pregnancy diagnosis in the mare 13
4.5. Management of twin pregnancies 14
4.6. Characteristics of pregnancy 15
4.7. Management of the pregnant mare 16
4.8. Pregnancy loss 18
4.9. Parturition 20
4.10. Foaling abnormalities 22
4.11. Post-partum complications in the mare 25
4.12. Post-partum events 27
4.13. The lactating mare and the young foal 28
4.13.1. Foal adaptation in the periparturient period and management of neonates 28
4.13.2. Management of the post-partum mare 30
5. Materials and methods 32
6. Results 33
7. Discussion 40

8. Summary 43
9. Bibliography 44
10. Acknowledgements 49
11. Appendices 50
12. Electronic License Agreement and Copyright Declaration 53

2. List of abbreviations

eCG	Equine Chorionic Gonadotropin
CL	Corpus Luteum
FSH	Follicle Stimulating Hormone
LH	Luteinising Hormone
PGF2α	Prostaglandin $F_{2\alpha}$
GnRH	Gonadotropin Releasing Hormone
hCG	Human Chorionic Gonadotropin
rLH	Recombinant Luteinising Hormone
BSE	Breeding Soundness Examination
BCS	Body Condition Score
CEMO	Contagious Equine Metritis Organism
EPF	Early Pregnancy Factor
EHV-1	Equine Herpes Virus-1
EHV-4	Equine Herpes Virus-4
EED	Early Embryonic Death
IgG	Immunoglobulin G
IgA	Immunoglobulin A
IgM	Immunoglobulin M

3. Introduction and Goals

The Thoroughbred breed originates from England. Breeding began approximately 200 years ago with the "oriental" foundation sires and 43 "royal" mares, which were imported from the Mediterranean Middle East to England by Charles II and became the ancestors of all Thoroughbreds. The foundation sires were Byerly Turk, Darley Arabian and Godolphin Arabian. James Weatherby founded the Jockey Club in 1750 with the goal to organise and regulate horse racing and breeding. Few years later he created the General Stud Book, which contains pedigree records of hundreds of Thoroughbred racehorses. Breeding in Hungary began when Baron Miklós Wesselényi and Count István Széchenyi brought the first horses in 1822. The Count was the one who realised the value of both Thoroughbred breeding and horse racing, and he also made the first rules of racing here, which were created based on the English Formula. The Animal Breeding Association, which was the forerunner of the Hungarian Jockey Club was also established and then Tamás Nádaskay created the first Stud Book [1–4].

The English Thoroughbred, since its inception, has had an enormous impact on horse racing and breeding in the world. As a result of careful breeding selection, management, and systematic competition system, mare families and stallion lines were created, which were decisive in maintaining outstanding performance, and whose influence can still be seen and also found in their descendants to this day [5].

For further development of the breed, it is crucial to establish the goal to be achieved and the decision should be based on economic and genetic considerations. "Good" pairing can only be achieved by careful observation and evaluation of broodmares and stallions [6].

For such reasons, this Thesis was dedicated to examine the breeding of Thoroughbred Racehorses in Hungary and to reveal the circumstances that can be significant of pregnancy period in broodmares, foaling and the foals. With my Thesis I can hopefully provide an insight to the Thoroughbred breeding industry and reveal factors that could be improved in order to reach higher reproductive efficiency and decrease the defaults over which we might slip.

Telivérfarm Kft. has more than 20 years of experience in both breeding and racing and their goal is to develop Thoroughbred breeding in Hungary in accordance with today's expectations while preserving the traditions. As of today, it operates as a subsidiary of Bácsalmási Agráripari Zrt. Breeding and running are closely intertwined in the life of Telivér Farm. Mares of excellent pedigree were purchased in the previous decades, which had also a good career and included in the breeding, thereby bringing a quality update to the gene pool. The performance of their own-bred horses influence the main directions of breeding and their results give a continuous feedback to them about which breeding decisions were the most successful.

4. Literature review

4.1. Manipulation of the oestrus cycle

Recently, the timing of mating is mainly influenced by humans in the breeding industry in order to achieve the highest conception rates and also to somewhat schedule the breeding, especially in larger studs. Organised breeding management is crucial to achieving this goal and reducing the number of covers per cycle. Operational breeding season starts earlier than the natural breeding season of the mares. In order to have the most mature offspring on the racecourse, breeders try to cover their mare at the beginning of the year, preferably starting from the 15th of February to have a foal born at the beginning of the next year. Several methods are available to manipulate the oestrus cycle of the mare, which are often used in combination. Just to mention some examples, advancing the breeding season by using artificial light is one of the most commonly used techniques because it does not require administration of any drugs and is also an affordable and good technique. Several pharmaceutical compounds are available to either induce ovulation or bring the next cycle forward and to synchronise mares. These drugs are hormones and are also able to remedy abnormalities in the cycles [7–11].

4.1.2. Artificial illumination

From winter anoestrus and acyclicity mares enter the spring transitional phase, in which they have 3-4 waves of follicular growth. These follicles are larger in size, around 25 mm, but these will not ovulate. Usually, these cycles are prolonged. There is a surge in Luteinising Hormone (LH) levels before the first ovulation and then regular cycles follow. When the first ovulation happens, breeding season starts. For mares to enter the breeding season at the beginning of spring, artificial manipulation of photoperiod might be required because the naturally occurring breeding season would only start around March-April. Artificial light can be used to induce breeding season earlier; hence it imitates spring light conditions and gradually decreases melatonin levels, which have a role in starting the cyclicity. It is important to take into consideration that this kind of manipulation needs time to be effective and the broodmare needs a period of time when she is in anoestrus. Sixteen illuminated hours a day for 8-10 weeks seems to be an effective protocol to induce regular cycling and ovulation earlier. Mares that are desired to be bred around the 15th of February shall be exposed to supplemental light from 1st of December. Exposure at dusk seems to be more effective than at dawn according to literature and the intensity of illumination shall be as much in the stable to be able to read a newspaper (approximately 100 lux). Special light masks (Equilume) are also available on the market, which are stimulating one eye of the mare with blue light during its “photosensitive window”

and seems to function effectively, not to mention the fact that it requires less labour, reduced costs, and mares can also be kept outdoors under more natural conditions [7, 10, 12–15].

4.13. Induction of ovulation

Once the mare starts cycling and have a pre-ovulatory follicle of appropriate size, ovulation can be induced via exogenous hormone therapy. Scheduling the breeding and decreasing the number of mountings in the breeding industry, where they only perform live covering, such as in Thoroughbreds, are advantageous. Prerequisites of exogenous hormone therapy to induce ovulation consist of regular monitoring the ovaries of the mare in heat with ultrasound. Ovulation of the mare most commonly occurs 24-48 hours before the end of heat/oestrus. Insemination or covering should be carried out to achieve the highest fertilisation rate before ovulation, approximately in a 36-hour time frame. Viability of the ovum lasts for 12 hours following ovulation respectively. The viability of the semen is longer compared to the oocyte. For this reason, close monitoring of broodmares and regular teasing are the recommended procedures [16].

The best candidates for hormone treatment are the ones with relaxed cervix, endometrial oedema, and a large pre-ovulatory follicle (>35 mm). Hormones that can be applied are the following: human chorionic gonadotropin (hCG), GnRH analogue, deslorelin and recombinant LH (rLH). The hCG, if given intravenously, induces ovulation within the next 48 hours. GnRH analogues, such as deslorelin, are available as injectable and subcutaneous implant forms, and also recently as a pulsatile mini-pump. Single dose on GnRH or its analogue alone are not enough to induce ovulation, since in the mare a longer LH-surge is required for ovulation. Compared to hCG, deslorelin can be applied in mares with smaller follicles (≈30 mm), but it will induce ovulation a bit later, ≈36-42 hours post-treatment. It is important to consider, that regardless of the hormone applied, appropriate technique and timing are crucial, otherwise the follicle may go under regression instead of ovulation, thus prolongs the cycle till the next ovulation [7, 10, 15, 17–20].

4.1.4. Shortening the cycle via inducing luteolysis

Generally, there are two main reasons for shortening the cycle. First is usually to bring the consecutive heat closer to foal heat. Foal heat present within 15 days post-partum. On most occasions, foal heat is fertile, but careful examination of the reproductive tract is recommended to evaluate the state and readiness for rebreeding. If it cannot be used to cover the mare, following ovulation, luteolysis can be induced and thus reducing the dioestrus and the

interovulatory interval. The second is, if for some reason covering the mare was not feasible. Regardless of the reason the goal equals, to bring the next heat and ovulation closer. The corpus luteum of the ovulated follicle becomes sensitive to prostaglandins from day 5 and prostaglandin will induce its regression (luteolysis). Following injection, the mare returns to oestrus in 3-5 days. If two injections are given 14 days apart, synchronisation of oestrus can be performed [10, 11, 15, 17, 19].

4.1.5. Feeding of gestagens

Feeding of gestagens, namely altrenogest, in horses are intended to synchronise or even suppress oestrus, and also to treat irregular cycles during the transition phase. Intravaginal and subcutaneous devices containing progestagens are not too preferred in the breeding industry due to their several side effects, difficult application, therefore feeding them became the part of the regular practice. The theory behind feeding these compounds is that it inhibits oestrus via decreasing pulse frequency of GnRH, and discontinuation of feeding results in oestrus occurrence via rebound effect. If given orally for 10-14 days in the transitional phase to control irregular cycles, on the last day of its application it can be supplemented with $PGF_{2\alpha}$ injection to induce luteolysis of the existing CL, and oestrus will follow in 4-5 days, thus allowing the schedule for breeding within a predictable time frame [15, 19, 21].

4.2. Breeding soundness examination of the mare

As it was mentioned in the previous chapter, the operational breeding season of Thoroughbred mares starts on the 15th of February and lasts till the 30th of June. The goal for breeders is to breed their mares in this timeframe, preferably to be as close to the starting date as possible to have a foal at the beginning of the foaling season in the consecutive year. For this to achieve, an optimal breeding management practice must be organised including the selection of mares to be bred and continuous monitoring of those. Breeding soundness examination (BSE) is done for the purpose to assess the health status, ability to bred, and may also be done as a part of pre-purchase examination. If a mare had a previous record of difficulty conceiving (repeated breeders), maiden and barren mares or any problems related to pregnancy she should also be checked in the beginning of the new season. A complete breeding soundness examination consists of the history and signalment, physical examination, evaluation of the external genital tract, palpation, and ultrasonographic examination of the internal genitalia, vaginoscopy, and cytologic/ histologic examination of the endometrium to investigate the presence of any infectious organisms. Additionally, blood samples may be obtained to check endocrine profiles.

For those mares that just had foaled, palpation, or ultrasonographic examination is carried out routinely to evaluate the involution of the uterus, and also the history of foaling has an importance (with regard to dystocia, retained foetal membranes, etc.) and if there is any mechanical damage to the reproductive tract. Detection of heat and continuous monitoring of breeding mares in the new season is crucial for optimal breeding management practices. Continuous monitoring and recording of the data are the prerequisites for the possible manipulation of the cycle with hormones and achieving successful fertilisation as early as possible. In those mares who just foaled, foal heat can be used for mating because this oestrus is already fertile. Foal heat usually occurs within 15 days after parturition. A thorough examination of the genital tract is required to evaluate the readiness of the mare to be bred again or to wait for another heat. The examination is recommended to be carried out via ultrasound to evaluate the quantity and quality of the fluid in the uterus and if endometritis is suspected for any reasons, such as retained foetal membranes, or disturbed involution. If anything abnormal is suspected or cannot be ruled out, it is recommended to wait for another cycle [22–24].

History and signalment are mostly helpful for the veterinarian to guide the route towards the diagnosis and determine the indication for breeding soundness examination. As it was mentioned before, indication for breeding serviceability includes repeat breeders, maiden and barren mares, abortions, external genital injuries, irregular cycles, infections, older mares etc. It is very important to ask the correct and relevant questions to have a good understanding of the situation with special regards to specific and general history of the particular mare [22–24].

Physical examination and body condition scoring (BCS) shall also be performed as a part of routine examination. Sometimes reproductive issues are associated with systemic illness, nutrition, keeping conditions, therefore it is crucial to rule out or confirm these factors. Body condition is associated with reproductive efficiency in a way that both thin and obese animals have difficulty conceiving. Literature suggest that the best reproductive performance can be achieved if broodmares are kept at average or a bit above average condition (6/10 or 3/5 BCS). Sometimes body condition is also an indicator to systemic diseases, such as Cushing disease, hypothyroidism, and parasitism, which are all decrease reproductive performance [25].

Physical examination of the animal shall include general assessment of vital functions (heart, lungs, digestive tract etc.), external conformation of the reproductive tract (both bony and soft tissues) and also status of the extremities and back, as she needs to carry increased amount weight throughout gestation. External conformation of the genital tract is of particular importance. Any external damage, laceration, scars may be indicative for internal issues too and should be taken into consideration. Predisposition to urovagina and pneumovagina should

also be considered as these can result in infections and infertility. Caslick index can be measured and calculated with a simple ruler to identify abnormal conformation of the perineum. Possible solutions of these abnormalities include Caslick vulvoplasty [22, 24, 26].

Before the internal examination of the reproductive tract, samples can be taken for bacterial culture and isolation from the region of the clitoris and clitoral sinus. The most common bacteria in question, that are transmitted venereally are Klebsiella pneumoniae, Pseudomonas aeruginosa and Taylorella equigenitalis, the causative agent of CEMO (Contagious Equine Metritis Organism) [23].

Following physical examination, internal examination of the reproductive tract is carried out from caudal towards the cranial direction, where each part is examined separately. Examination consists of manual or digital palpation and also visual assessment of the genitalia with the help of speculum, or endoscope/ hysteroscope and ultrasound . Before any procedures the perineum of the mare must be washed and cleaned thoroughly and with the general aim to be as sterile as possible during any examination to avoid infections, therefore wearing gloves and sterile equipment are part of good practice. When examining the vulva and the vagina, any discharge, contamination or inflammation must be ruled out. The normal appearance of the vagina when examined with a speculum is pink, clear lining of mucous membranes, mucous is clean, transparent. There are no scars, tears, or signs of injury or any signs of tissue proliferations suspicious for cysts/neoplasms. Inserting the speculum towards the cranial direction gives rise to examine the cervix, which appear differently depending on the stage of the oestrus cycle. When the mare is in oestrus, cervix is relaxed, pink, flaccid and moist. At dioestrus, the tone is increased, has a whitish/ lighter colour, with thicker secretions and appears to be tightly close. Samples can be obtained from the cervix for bacterial examination and to evaluate the discharge if there is any. The uterus can only be palpated transrectally or assessed with endoscopy or via ultrasound. Tone, size, and texture can be evaluated via rectal palpation, colour and condition can only be visualised with digital tools. Same as in case of the cervix, checking the size, length, tone, appearance, fluid content and injuries of the uterus are performed in a routine manner. Uterine culture can be taken because it provides valuable information about the reproductive potential, even though contamination of the swab sample happens relatively frequently. Culture may be combined with cytology and biopsy for histology, in that way false results can be excluded, and also proper choice of treatment can be selected upon needs, such as in case of infectious endometritis. Ovarian activity is the last to be determined [27, 28].

4.3. Covering

Hungarian Gallop Racehorse Breeders Association revised and published its rules of entry to the Hungarian Stud Book for Thoroughbreds in 2018, which states that "The Thoroughbred must be the result of a stallion's mating with a mare which is the physical mounting of a mare by a stallion with intromission of the penis and ejaculation of semen into the reproductive tract" [29] and also that "Artificial insemination, embryo transfer or transplant, cloning or any other form of genetic manipulation is prohibited in Thoroughbred breeding." [29] Therefore, as in other countries throughout the world, only live cover is accepted as a mating method among purebred Thoroughbreds.

The mare will only accept the stallion if she is sexually receptive, thus she is in her oestrous phase. Ovulation occurs 24-48 hours before the end of oestrus. Survival of the semen of the stallion is longer compared to the ovum, therefore mating shall be scheduled around ovulation, preferable pre-ovulation as the viability of the ovum decreases drastically post-ovulation (≈12 hours). In most breeding studs, the mares are covered every 48 hours till the end of oestrus, around two times per oestrus. In ideal conditions one mount per cycle would be the goal [16, 30, 31].

When the mare was confirmed to be in oestrus, it is then scheduled for breeding. Before that, some precautions must be taken to prevent contamination, infections, and injuries during the procedure. The tail of the mare is usually wrapped with a bandage, then thorough scrubbing and washing of the perineum is carried out. The personnel shall wear gloves and use a solution which has low or no spermicide property, then wash the area with rinse, clean, fresh water and dry it off. Shoes on the hindlimbs of the mare should also be removed to prevent harm of the stallion while kicking him and upon entering the covering area covering boots may be put on her hindlegs. If Caslick vulvoplasty was performed before, the stiches should be removed. Depending on the temperament of the mare, additional tools, such as twitch, hobbles, blinkers, blindfold etc. may also be applied. Drastic restraint of the mare, however, should be avoided if possible because it might affect conception rate adversely. A wither pad on her back may also be applied to prevent bite injuries during mounting. Tranquilizers are last choice to restrain a mare, as excessive aggressive behaviour is not preferential and further intention for breeding purposes shall be questioned. One person should lead the mare on a bridle to the covering area. The stallion should also be scrubbed and washed thoroughly in his genital area, penis, belly, and inner part of his hindlegs using rinse water and a non-spermicide product at the washing area. If possible, only minimal restraining techniques shall be applied, such as a covering bridle and a long rein to be able to lead him and tack if necessary. Upon washing, some stallions

already erect their penis, while some needs prior teasing. After the general precaution procedures, the stallion joins the mare at the covering area with another personnel. The covering area should be a calm, dry and safe place designated for the procedure with a surface that prevent slipping (e.g., rubber matting). Recommendations are to be at least 20x12 metres with roof, two doors, with clean, non-slip surfaces [32].

The technique of covering varies largely among countries and within studs. In the Thoroughbred industry in-hand breeding is the most common practice. The minimum required number of personnel is two, however the recommended is four, out of which everyone has an exact role to avoid confusion and injuries. One-one personnel should lead both the mare and the stallion, and the mare should arrive first to the covering area, then depends on the system used, she either meets the stallion first in a teasing pen or not. Third personnel help to position the penis of the stallion and also with intromission, while holding the tail of the mare. A fourth handler may also present to prevent the mare from tottering too far, as it is a risk of injury for both of the animals. It is important to note that excess external stimuli and disruption may have an adverse effect on the procedure, thereby it should be minimalised. The stallion should be allowed the mare when his penis is fully erected. Successful ejaculation can be visualised by the rhythmic flagging of the tail or via the urethral contraction felt in a way, that one hand is placed on the ventral part of the penis. Before dismounting, the stallion usually spends some time relaxing on the mare, while the penis is withdrawn, which is preferential and should not be intermitted as it can also injure both of them. After mounting, when all the limbs of the stallion are on ground, he should be lead away from the mare [32–34].

Following breeding the mare has a normal inflammatory reaction in the uterus (endometritis), which, if not resolved in 12 hours, results in persistent post-breeding endometritis. Post-breeding endometritis is of today still a leading cause of infertility and subfertility in broodmares. It is due to the fact that persisting endometritis, which is not resolved in five days after breeding, creates a cytotoxic environment and the embryo which enters to the uterus at day 5 will not survive. There are several predisposing factors, such as abnormal reproductive conformation, defective uterine contractility, thus clearance. These factors may be combined. Based on the aetiology and pathophysiology, endometritis can be grouped into four categories, which may be combined. The groups are the chronic degenerative endometritis or endometrosis, persistent mating-induced endometritis, chronic infectious endometritis, and sexually transmitted diseases. Diagnosis of endometritis is possible via ultrasonographic examination, cervical and uterine discharge, cytology, and bacterial culture obtained from swab samples and biopsy. All the mares should be examined soon after breeding to be able to treat

the condition if necessary and to prevent infertility. Treatment options include uterine lavage and after bacterial culture or cytology antibiotic treatment in case of positive results. The aim of treatment is to clear the excess content from the uterus [35–39].

4.4. Pregnancy diagnosis in the mare

In the breeding industry not only pregnant mares are important, but also the ones who had been covered recently but did not conceive. Early detection of empty mares is crucial to be able to rebreed them as soon as possible. If the diagnosis of pregnancy is established, these mares should be managed accordingly and later on should be examined for twin pregnancy. The ideal test to confirm pregnancy would be an accurate, early, inexpensive, single test, which is uncomplicated, however, there is no such method available on the market yet. Moreover, these tests are unable to detect twin pregnancies and the viability of the embryo, and behavioural signs of pregnancy alone are not reliable to confirm pregnancy. Both pregnant and non-pregnant may show oestrus-like behaviour or not at all. In the non-regnant mare, persisting corpus luteum may suppress the signs of oestrus, therefore they should be differentiated from pregnant. Sometimes mares that conceived are show oestrus-like behaviour around day 35-40 due to the oestrogen effect. Oestrogen originates from follicles that will become secondary CLs [40–42].
Rectal palpation is one of the oldest methods to confirm or rule out pregnancy, however, it is only accurate 20-35 days post-breeding, sometimes only after 50 days. From 18-20 days onwards, only the thickness of the uterine wall might be indicative and then the embryonic vesicle can be palpated manually and evaluated based on its size from approximately day 35. Rectal palpation is safe, quick, easy, and unexpensive but it is not reliable early enough to detect empty mares and allow them to be re-bred as soon as possible [40–42].
Ultrasound examination gives the opportunity to confirm pregnancy as early as 11-12 days post-coitum with reliable results, thus it became the most common diagnostic tool in the past years. Not to mention the fact that gender and fetal viability can also be evaluated with this technique based on heartbeat, movement, size etc. In the beginning, the embryonic vesicle can be detected, and it is moving within the uterus. At around day 17-18, it is fixed near the end of the uterine body and uterine horn, thus diagnosis might be easier. From day 40 on, clear structures and features can be visualised. In Thoroughbred studs, mares are usually checked on these three above-mentioned occasions. The goal is to select the ones which did not conceive and to rule out or confirm twins as it is very common in this breed and must be managed [40–43].
Hormone profiles are also available to confirm pregnancy, even though they have their limitations as being relatively expensive, results need time and also cannot detect pregnancy

before day 40. Equine chorionic gonadotropin (eCG) is one of the hormones to check, but it is secreted by the endometrial cups in the uterus, which develop only on day 36-40 of gestation. Therefore, the measurement of eCG becomes relevant only after day 40. In case of embryonic loss after day 36, false positive results might be obtained due to the developed endometrial cups. False-negative results are common before day 36 (no endometrial cups) and above day 120 of gestation (regressed endometrial cups). Progesterone levels can be measured around day 17-22 and should be high (> 2 ng/ml) in serum, but results should be carefully evaluated as cyclic irregularities, persisting CL may give similar elevated results. After day 60 of gestation oestrogen in its conjugated form, oestrogen sulphate can be detected in the plasma of the pregnant mare. A combination of hormone profiles may give a better picture and more reliable results. Other hormones, such as relaxin, and also a protein called early pregnancy factor (EPF) can also be measured [15, 40–42, 44].

4.5. Management of twin pregnancies

Twin pregnancies in horses are undesirable, because, at a high percentage, they lead to the early embryonic death of one or both of the embryos as the reproductive tract of the mare is only "designed" to support a singleton foal at a time. In case they survive early gestation, abortion is a risk as it is the leading cause of non-infectious abortion in horses. If carried to term, these foals are either stillborn or weak and have low vitality. Moreover, mares with twin foals are more prone to dystocia, retained foetal membranes and complications following parturition. In Thoroughbreds, twin pregnancies are relatively common, being around 16% according to research [45, 46].

Early identification and management are done at most Thoroughbred studs to reduce twin foaling with great success [47]. Ultrasound-guided manual reduction became one of the most commonly done practices at an early stage of pregnancy, preferably before the fixation of the embryos at day 18 of gestation. Usually, the smaller embryo is removed. If fixation has already happened, manual reduction of twins located in different horns of the uterus (bicornuate) can still be performed with great success, however, if they are unilateral, reduction may risk terminating the whole pregnancy. Sometimes twin pregnancies are naturally reduced to one. Another technique is to induce abortion in the mare with the administration of $PGF_{2\alpha}$ before the next oestrus (before day 21) and breed the mare again. Hormone injection to induce abortion must be administered before day 40 of gestation because this is the time when endometrial cups are forming and only regress at day 100-120 of gestation. These are producing eCG, which will

induce newly forming CLs and therefore return to oestrus and thus, rebreeding will not be possible [15, 40, 43, 46, 48].

4.6. Characteristics of pregnancy

After successful fertilisation in the upper third of the oviduct, the conceptus needs approximately five days to travel along the reproductive tract of the mare and get into the uterus. It is a unique feature in the pregnant mare because the uterus needs roughly the same amount of time to heal from post-mating endometritis, which is a physiological inflammation following mating. For the conceptus to be recognised by the mare (maternal recognition), it has to travel and move to all the parts of the endometrium between day 12-14, otherwise, it will be luteolised and the mare will return to cycling. At this stage, the embryo can already be identified by using ultrasound and is termed the mobility phase. Fixation of the conceptus occurs around day 16 of gestation in the base of one of the uterine horns. First, the embryo is on the ventral side of the conceptus and then as the allantois develops, the embryo will be raised towards the dorsal direction. The yolk sac is surrounded by the mesoderm, which is responsible for carrying the blood vessels. The umbilical cord is attached to the dorsal side. Organogenesis of the embryo lasts till day 35 and this is the point where it is termed a foetus. Around day 40 the main body features, such as the extremities, nose, eyes, and ears become evident. Final implantation occurs around day 50-60. The foetus is located in one of the uterine horns, then it will be in the uterine body from 70-80 days of gestation till 6-7 months and it will lay in the same presentation following this stage. Till stage two labour the foetus is in a lateral or ventral position, with flexed head and extremities [49, 50].

The maintenance of an adequate environment and protection of the embryo is the responsibility of the placenta. Metabolic exchange of nutrients, oxygen and waste materials are done through it. It is formed from the trophoblast of the blastocyst, termed extraembryonic membranes. The type of the placenta anatomically is “placenta diffusa” and “microcotyledonaria”, while histologically it is “placenta epitheliochorialis” and it consists of six distinct layers [15]. There are blood vessels developing from the yolk sac and then the vitelline vessels, an artery and a vein develop, which will be the blood-carrying systems of the placenta. Placental attachment starts around day 25, but it will remain loose till term to provide easy separation during labour. Placenta covers the whole uterine surface with the exception of the cervix and the uterotubular junction. Microcotyledons are responsible for the extension of the surface area where the metabolic exchange of nutrients between the mother and foetus occurs. Diffusion of large molecules, such as immunoglobulins, is limited, thus passive immunity of the foal is supported

primarily via the colostrum after birth. According to literature the surface of the placenta influences the birth weight of the foal in a way that the larger it is, it can provide more nutrients to the developing foetus, thus being larger at birth [50, 51].

Endocrinology of pregnancy starts similar as the luteal phase of the non-pregnant mare. Changes start when the endometrium would secrete prostaglandins 15 days after ovulation respectively, which causes the regression of CL and thus the returning to oestrus. In the pregnant mare, around this time the embryo has its mobility phase, which, by its constant movement with the goal to contact all parts of the endometrium, prevent the release of prostaglandins. This phase is the maternal recognition and is crucial in the development of pregnancy. Around day 25, the CL formed from ovulation has a declined progesterone secretion, but it is still over the non-pregnant level, > 1ng/ml. When endometrial cups are formed around day 40 and start to secrete eCG, which is responsible for the development of secondary or accessory CLs and these are taking over the progesterone secretion, which is indispensable for the maintenance of pregnancy in the first five months. When endometrial cups regress around day 90-120, progesterone also declines, and then the foeto-placental unit takes over the primary secretion at day 200 and will be the only unit which secretes the hormone, thus the second half of the pregnancy becomes independent from CL. Other hormones are also present and alter changes in the pregnant mare, which are only discussed as a part of some chapters [49, 52–55].

Duration of pregnancy in the mare is approximately 330 days with a great variability between 310-370 days. Literature suggests that the date of conception, gender of the foal and individual variations may be responsible for the great variations. Under intensive keeping conditions, such as in Thoroughbred studs, the exact days of mating and foaling can be noted, thus the exact duration of pregnancy can be calculated, which makes it possible to monitor and study this period more closely [49, 56, 57].

4.7. Management of the pregnant mare

Management of the pregnant mare relies generally on six pillars according to literature, which are as follows: nutrition, exercise, deworming, vaccination, dental and appropriate foot care. Investigating environmental factors on foetal well-being are not well studied at this stage as it is being a very complex area. Body condition as it was mentioned in the previous chapters are important for successful fertilisation and also through pregnancy and post-partum period. Gentle exercise of pregnant mares is allowed up until 6 months of pregnancy, but the ideal condition for them would be to graze on pastures and exercise at their will. Exercising is proven

to reduce excess water and oedema formation, which is more common in mares that are kept in boxes. Stress and exhaustion should be avoided as it is proven increase the risk of termination of pregnancy at any stage. Nutrition-wise, mares that are pregnant with foal on foot with them shall be fed differently from the ones being pregnant only, as the former ones are pregnant and lactating at the same time, thus they require more nutrients for their healthy being. When putting together the daily ration for pregnant mares, the general principles of nutrition apply, where the important nutrient are the digestible energy, protein, vitamins, and minerals, which should be balanced accordingly. Generally, a body condition score of 3 on a scale of 5 is said to be the ideal for pregnant mares. They should not be obese nor underweight as both influence gestation and parturition adversely. Obesity at parturition may increase the risk of dystocia as it is limiting uterine size and pressuring organs. Only in the last trimester, their daily requirements and weight gain increases markedly, because that is the period when foetal growth is the largest. Poor quality of feed prolongs gestation, increasing the risk of developmental abnormalities, low vitality foals and even causes abortion if contains fungi and mycotoxins. Fresh, clean, and constantly available water source should be provided for the all the horses, regardless of their conditions and their general needs are around 10% of their body weight, which is around 45 litres a day. Internal parasite control is of outmost importance. There are many protocols available and differ within studs but the most important is to have a targeted therapy, pastures should be rotated if possible and heavy infestation should be prevented. Some literatures still suggest deworming in every 2-3 months, but not to administer anything in the last month of pregnancy, others suggest rarer application. Always use a product which has no or the least adverse effects on pregnancy and if possible, to a targeted therapy after faecal egg count. Immunisation recommendations also differs within countries and mostly are only recommendation instead of being mandatory. Equine Herpesvirus 1 and 4 (EHV-1, EHV-4) causes viral abortion, rhinopneumonitis and sometimes neurological disorders, therefore it is recommended to vaccinate pregnant mares in the (3^{rd}), 5^{th}, 7^{th} and 9^{th} month of gestation. Tetanus and Rabies can be a risk to any horses anywhere, therefore yearly vaccination is recommended and also one month before gestation. Vaccination against Equine Influenza is mandatory in racehorses in every 6 months after basic immunisation. Other additional vaccines are also available such as Rota virus, Equine Viral Arteritis and West-Nile Virus. Immunisation of the mare not only prevents the occurrence of these diseases in the mare but also provides antibodies for the foal transferred in the colostrum [41, 58].

4.8. Pregnancy loss

Loss of pregnancy in the mare is more common in early stages, especially during the embryonic stage, which is till day 40 of gestation. Early embryonic death (EED) is termed before day 40 and after that till day 300 it is termed as abortion. Stillbirth means the loss of pregnancy over 300 days of gestation. Early embryonic mortality rate is approximately 5-15% and the most common causes include early luteal insufficiency and twin pregnancy [15, 59]. It is difficult to determine the rate of EED before the confirmation of pregnancy with ultrasound or rectal palpation, so before around day 12. Early luteal insufficiency in mares is a relatively common phenomenon. If the primary corpus luteum progesterone production markedly declines before the development of the endometrial cups, EED has a high chance to occur. To prevent the occurrence of EED at this early stage, breeders are commonly giving exogenous progesterone source (e.g., Altrenogest) till day 100 of gestation [60]. Twin pregnancies, as it was mentioned before, are common causes of either EED or abortion. Many cases either one or both of the embryo dies. If they survive and are not managed early or at all, there is a high risk of abortion and stillbirth. There are other reasons for embryonic loss in mares, such as chromosomal abnormalities, late fertilisation with old sperm, inherited genetic abnormalities, teratogenic agents, age of the mare, foal heat mating, poor body condition and nutrition, laminitis, uterine problems and stress, failure of maternal recognition etc. Causes of embryonic death can be categorised into three groups: maternal, external, and embryonic [15, 61–64].

After day 40 of gestation till day 300, termination of pregnancy is called abortion. Abortion can be induced by either infectious or non-infectious factors and be either acute or chronic. Acute abortions, as the name indicates, occur spontaneously with no premonitory signs, while chronic ones usually have preceding signs. Rate of abortion among covered mares varies, but generally the same as EED being between 5-15%. If abortion occurs or suspected, the mare should be isolated and the aborted content, such as the foetus, placenta and fluid shall be removed as they are being potential sources of infection until confirmed otherwise. Most commonly, placental dysfunction is the one terminating the pregnancy, which has both infectious and non-infectious pathomechanisms. Placentitis is the inflammation of the placenta and a typical finding in case of infectious abortions, and it can be further categorised into acute and chronic. Route of infection can be: hematogenous, such as in Leptospirosis, from the uterus or vagina, such as Streptococci or via the umbilical vein or amniotic fluid. Other placental dysfunctions are hypoxia, defective placenta in case of hydrallantois, placental attachment disorders, oedema, local immunoreaction, malnutrition etc. Dysfunction of the placenta not always result in abortion, it might be the reason of malformation of the foetus, stillbirth, retarded growth,

septicaemia etc. Undiagnosed twin pregnancies are the number one causes of non-infectious abortion of mares, which can be reduced markedly with regular monitoring and early management. Twins conceived from double ovulations, which has a relatively high rate among Thoroughbreds (≈15 %). Mares have the availability to reduce naturally twin pregnancies at an early stage if those are fixed in the same horn, thus being unilateral or unicornuate. Problems resulting in abortion over 40 days of gestation arise from twins that are situated bilaterally, meaning they are different horns, because the mare cannot reduce one of them naturally. Manual reduction or crushing one of the twins before day 40 has a great success rate and this is the commonly done practice. Body pregnancy means that the conceptus is fixed at the uterine body instead of one of the uterine horns and associated with high risk of placental insufficiency, which also causes non-infectious abortion in the mare. Careful examination of the mare is required to confirm body pregnancy as it is being a relatively uncommon condition and can be confused with regular fixation. Possible solutions include the termination of pregnancy with prostaglandin administration before endometrial cup formation, thus allowing the mare to return to oestrus and be bred again in the season. Premature placental separation may occur during birth or mid- to late gestation. Foetal hypoxia is the risk factor if occurs during birth as the chorioallantois does not rupture, thus allantoic fluid is not released. The condition can be fatal and result in stillbirth if not recognised and managed on time. There is a variety of causes of early placental separation including stress. Another cause of non-infectious abortion, which may also lead to the death of the foetus and even the mare, is the uterine torsion and has different types. It can occur any time after mid gestation and also during parturition. Uterus can twist in a clockwise and anticlockwise direction with a grade of under or above 180 degrees. In severe cases it may also result in uterine rupture, which almost always cause the death of the foetus. Diagnosis is based on palpation per rectum or per vaginam, with the assessment of the broad ligaments, thus the direction of the torsion can be evaluated. Correction of the condition is required as soon as possible to prevent the loss of the pregnancy. In grazing mares, increased amount of fescue grazing may result in prolonged gestation or even fescue toxicosis, as there is an endophyte fungus growing on it and being the causative agent of the condition [15, 64, 65]. There are plenty of infectious causes of abortions in the mare, out of which some can be prevented with good immunisation protocols and some others with good keeping and management practices. It is very important if there is an abortion in the stud, where other pregnant mares are kept, to investigate the cause and rule out abortion of infectious or contagious origin. Diagnosis of the causative agent include the history, clinical sigs, post-mortem findings, and sampling of the aborted material, including the placenta, foetus, and other

contents for serologic, microbiologic, and histopathologic examinations. Equine Rhinopneumonitis (EHV-1) is a relatively common cause of acute abortion in the last trimester of the pregnancy in non-vaccinated mares. Preventive measures are the vaccination of the mares during gestation in their 3rd, 5th, 7th, and 9th months. It may also induce abortion storms among studs, thus careful examination and isolation of the aborted mares are required. Equine Streptococcal abortion may also induce abortion storms under 200 days of gestation but may happen at any stage and the causative agent is Streptococcus zooepidemicus. Others causes sporadic abortions in different stages of pregnancy are bacteria such as Nocardia, Escherichia coli, Pseudomonas aeruginosa, Leptospira, Brucella and Salmonella. Viral infections such as Equine Viral Arteritis caused by a Togavirus, against which vaccines are available but cannot be administered for pregnant mares. Autolytic foals with evident bacterial septicaemia present if aborted around 4-6 months of gestation, while the ones aborted in later stages are less autolytic, but placental lesions are more evident. Age of the foetus, time of the infection, immunocompetence, virulence and the rate of placental dysfunctions are all contributing to the appearance of the lesions and the characteristics of abortions [15, 64, 66–68].

4.9. Parturition

Gestation length varies among individuals and the normal length is usually defined in intervals rather than in exact days, being normal between 320-380 days with a general medium of 11 months (330 days). Parturition before day 300 is termed abortion, while parturition that did not occur within 360 days is termed overdue. According to literature early foaling in the spring tends to have a longer gestation length compared to those mares that foal later in the foaling season. In intensive breeding units, such as in the Thoroughbred industry, the exact days of mating are recorded, thus gestation length and prediction of foaling can be made. Pre-partum mares should be introduced to the foaling unit, if there is any, some weeks before parturition to avoid sudden changes and stressors in the environment. The foaling unit should be clean, soft, dust and sharp object free. Signs of imminent parturition should be monitored to predict the time, which includes the increased size of the mammary glands, milk secretion or waxy content on teats and the relaxation of pelvic musculature and perineal area. Also, behavioural changes may be represented in a form of abdominal discomfort and as a result of pressured abdominal organs and increased motility of the foal. There are other techniques available, such as the measurement of calcium concentration of the milk as it drastically increases before foaling and commercial kits are available for detection. Digital devices are available, which can be implanted and send a signal when the birth canal dilates to predict parturition more precisely.

Previous history of difficulty foaling should be considered to have assistance if needed. It is possible to induce parturition and done in order to have assistance present if required, however success rate is controversial and may have many side effects according to literature. The common agreement is to induce labour as close to the normal due as possible and careful examination of the mare should be carried out to assess the degree of relaxation of the pelvic ligaments and cervix and the state of the mammary gland and also foetal maturity. Premature foals may suffer from permanent damage if they survive, including breathing difficulties, late stand, and decreased vitality. Synthetic prostaglandin derivates and oxytocin are the most common drugs for inducing parturition, administration of corticosteroids, such as dexamethasone has controversial results. Labour or giving birth is a continuous process, even though literature often divides it into three stages for mainly descriptive purposes. First-stage is characterized by the onset of uterine contractions and cervical relaxation. It lasts approximately for an hour, but individual variations exist being 30 minutes to 6 hours. There is an increased foetal motility as it turns from upside-down position to a dorsosacral position. Sometimes mares are rolling over to facilitate the process. The mare may also become restless, frequently defecates/ urinates, sweats. Stage one typically ends when the chorioallantois ruptures at the cervical star which is seen as a fluid release (allantoic fluid), typically tan-red coloured. If chorioallantois appear as a dark red “vesicle” in the vulva, it should be manually ruptured. Stage two labour begins at this phase and is more important as the previous. A white structure, termed the amnion should appear and bulge out from the vulva. This structure should break by its own, careful monitoring of the colour should be taken. If it remains white, there is a high chance that assistance will not be needed. If it appears as greenish brownish, it is the evidence of meconium staining and foetal stress and assistance is required to expulse the foetus as soon as possible. The mare may lay down to a recumbent position to allow more effective expulsion. Correct position of the foal may also be assessed. If the forelegs are visible with one leg slightly advanced and the muzzle can be felt, the mare will almost always have a normal delivery and should be left to give birth naturally. Stage two labour lasts approximately for 5-30 minutes. Gentle helping for the mare to expulse the foetus might be advantageous if she is exhausted. After delivery, the umbilical cord should break naturally, which minimize blood loss. If it does not break naturally, it can be done with a sharp pull while holding the abdomen of the foal with the other hand and it should be disinfected with chlorhexidine to prevent infection. A foal may be dried off after delivery and the mare should be left in a recumbent position to gain some energy and recover. The vulva is still relaxed and in recumbent position air passage and bacterial infection are less likely to occur. Third stage labour starts after the

delivery of the foal and the main event surrounding the stage is the expulsion of foetal membranes. Average length of the stage is around one hour but also has a great variability. The placenta should be expelled with all of its parts because any remnant remains in the reproductive tract may lead to acute septic metritis or even septicaemia, which can be a fatal condition. Examination of the completeness of the placenta after delivery should be done to evaluate if there are any retained fragments, which should be treated immediately. If third stage labour exceed twelve hours, it is indicative for retained foetal membranes. Also, in this stage a bond between the mare and the foal is established and should not be interrupted. Aggressive behaviour towards the foal is very rare but if happens the mare might be tranquilised for some time [15, 69–73].

4.10. Foaling abnormalities

Difficult foaling or dystocia is associated with complications during birth, thus preventing natural expulsion of the foal and they always require emergency intervention. It is a relatively rare condition among mares and frequently associated with large foetus size, maternal problems and malpositions. It is being more common in first-foaling mares compared to those that had already foaled. The incidence of dystocia cases among Thoroughbreds are reported to be around 4% [74]. The primary goal when solving cases of dystocia is the earliest delivery of a healthy foal meanwhile also saving the mother, therefore rapid intervention is key. Possibilities of solving dystocia cases are the manual correction and gentle traction of the foal or Caesarean section or foetotomy. Caesarean section success rate in the mare is very low, as foals usually do not survive and mares often have complications, such as decreased reproductive competence, retained membranes, endometritis, and adhesion formations. Foetotomy is last resort intervention, and only performed when the foal is unalive thereby, saving the mare is the only goal. It is the recommended technique to be performed if the foal confirmed to be dead in utero as Caesarean section has more known complications and more costly. Assisted vaginal delivery means when the mare is actively taking part in the delivery, while controlled vaginal delivery is performed under anaesthesia. Cases of foetal dystocia are the ones that derived from complication of foetus, such as the malpresentations in utero. Foals in the womb can be characterized by the presentation, position, and posture. The relationship of the long axis of the foal to the long axis of the mare is defined as the presentation and is normal if the foal is in anterior longitudinal presentation. The relationship between the dorsum of the foal to the pelvis of the mother is the position and is normal if dorsosacral. Situation of the extremities of the foal is described by the posture and is considered normal if the head, neck, and forelimbs are

extended, where one of the forelimbs advance the other to ease the delivery and reduce the diameter [75]. Before any intervention is taken, careful obstetrical examination should be carried out to assess the above-mentioned positions and if there were any injuries in the reproductive tract of the mare, which would jeopardise the process of assistance. For the reposition of the foal, epidural anaesthesia may be applied, and the most commonly used drugs are lidocaine or mepivacaine [73].

In cases of forward presentations, one or both of the forelimbs are folded or flexed under the body of the foetus, while the head remains in its normal position. Sometimes the head is flexed backwards or ventrally and only the forelimbs are visible making the diameter wider and impossible to deliver the foal without assistance. Same situation if the forelimbs are above the head and lodged behind the ears, which is termed foot nape. These abnormal presentations can be fixed with pushing the foal back gently and correcting the presentation of the head and the limbs. Muscle relaxants may be administered to counteract uterine contractions when pushing the foal backwards. Carpal flexion is relatively common among dystocia cases, and it might affect one or both forelimbs. Carpal flexions can be solved via the extension of the affected limb. Shoulder flexion is relatively rare, and it can be uni- or bilateral. Conversion the posture to carpal flexion, then correcting it is the protocol indicated in the literature. Epidural anaesthesia may help to facilitate solving shoulder flexion cases, in case the foetus cannot be delivered Caesarean section, or if it is dead, Foetotomy is the recommended technique. Upward displacement of the forelimbs (one or both) above the head is termed foot nape and usually can be solved in standing position. Dog-sitting position is when the hindlimbs are extended under the pelvic rim with flexed hip. Caesarean section should be considered if the foal is alive as it is difficult to solve and often results in the loss of the foal [73].

In cases of caudal or backward presentation, the goal is to deliver the foal as soon as possible, to extend the limbs to be able to pass through the birth canal. Sometimes bilateral hip flexion (breech presentation) or transverse presentation occur, in these cases the survival of the foal is highly reduced. The main problem with backward presentation is that the umbilical cord may be trapped and thus the oxygen supply of the foal is reduced, and it suffers from asphyxia. Inspiration of allantoic fluid is also a risk. True breech or bilateral hip flexion is the position where only the tail of the foal can be palpated. In these cases, Caesarean section or if the foal died foetotomy is justified [73].

Ventro- and dorsotransverse presentations are uncommon and associated with uterine body pregnancies according to literature. In these cases, the foetus is usually oversized. In case the foal is still alive, Caesarean section is indicated immediately as manual reposition of these foals

are almost impossible due to the limited space available. If the foal has already passed away, partial foetotomy is the indicated procedure to remove one half of the foal, then the other can be repositioned and delivered [73].

If dystocia cannot be solved within 15 minutes with assisted vaginal delivery in a standing position, the mare should be anaesthetised and controlled vaginal delivery shall take place to increase the chances of survival. After anaesthesia the mare is usually turned into dorsal recumbency with the hind limbs elevated to ease abdominal pressure and create space for interaction. If the foal is confirmed to be dead in utero, Foetotomy is performed instead of Caesarean section, as the time and rate of recovery is better for the mare with less complications. Removing the head and neck in case of lateral or ventral deviation is required making the foal smaller [73, 76].

In all cases when manual managing of dystocia is decided, it should be done gently to prevent any injury that is unjustified. Lubrication is crucial to be able to manually interact. Try to apply traction force when the mare is contracting and let her some time to rest. Maximum three person should perform traction at the same time. Upon the decision of Caesarean section, it should be performed within an hour after the onset of stage 2 labour. Placental detachment may also occur, and it decreases foetal survival rate [77, 78].

Congenital defects may also result in foaling abnormalities. Many types of congenital abnormalities occur, to mention some examples: hydrocephalus, fetal anasarca and monsters [73].

Sometimes difficult foaling is the result of the abnormality of the birth canal, such as previous injury of the pelvis, which reduce the diameter of the canal and thus being too small for safe delivery of the foal. Examination of the reproductive tract prior to mating is therefore crucial. Previous severe laceration of the perineal area may also result in dystocia as these tissues are usually replaced by scars which cannot extend or dilate its size and therefore results in the reduced size of the birth canal. Tumours or other obstructive lesions may also present, such as leiomyoma or melanoma, which can be diagnosed before mating or during gestation. Ruptured prepubic tendon or abdominal rupture are incurable conditions and indication for Caesarean section to save the foal and the mare should be euthanised humanely after delivery. However, these pregnancies are commonly associated with hydrallantois, twins or large foetus. Clinical signs are the massive ventral swelling and oedema with marked abdominal pain and often the animal is recumbent. Uterine torsion cases are also candidates for Caesarean section. Uterine inertia is the condition when the uterus fails to strain during stage 2 labour and expulse the foal, resulting in dystocia and needs assistance. Administration of oxytocin to induce muscle

contractions and gentle traction of the foal or performing Caesarean section are the indicated procedures. Hydrops of the foetal membranes are conditions associated with excessive foetal fluid within the membranes and have two types, the hydrops amnion and allantois. They may occur during gestation and often result in non-viable foals [65, 70, 73, 74, 79–81].

4.11. Post-partum complications in the mare

Foetal membranes should be expelled in 30 minutes to 3 hours post-partum during stage 3 labour, however, if there was dystocia, uterine atonia or any disturbed events the placenta as a whole or some fragments of it might be retained. Literature considers retained placenta if not expelled in 3 hours and the incidence of the condition is ranging from 2-10 % in broodmares. Dystocia itself seldom predisposes to retained foetal membranes due to uterine trauma, exhaustion, and disturbance of contractions. Risk of retention increases if placentitis occurred during gestation. Expulsed foetal membranes should be examined post-partum to evaluate completeness. If any fragments remain in the uterus and are not expulsed within a short period of time, it may induce post-partum metritis, septicaemia, toxaemia, and laminitis and may be fatal for the mare if remains untreated. Treatment protocols recommend the administration of oxytocin intravenously or intramuscularly. Slow intravenous administration has been reported to be more physiological and induce less intense responses. Additional treatment options are uterine lavage, antibiotics, and gentle exercise. In cases of suspected septicaemia broad-spectrum antibiotics may be given both systematically and intrauterine. In cases of toxaemia, cyclooxygenase inhibitors, such as flunixin meglumine is given intravenously to prevent cardiovascular disturbances. Uterine involution and return to oestrus might be delayed in case of retained placenta [79, 82, 83].

Acute septic metritis may occur within 10 days after foaling and the main causative agent is Escherichia coli, a Gram-negative bacterium. It is a very dangerous and life-threatening condition and is thought to be more common in draft horses, rather than light horses, such as the Thoroughbreds. There is a severe inflammation of the uterus and myometrium and the risk of absorption of toxins into the systemic circulation is very high. Retained placenta and dystocia predispose mares to septic metritis and require emergency treatment. There is an acute onset of fever, depression, diarrhoea and even laminitis due to the septic consequences of inflammation. Fetid, dark vaginal discharge may be indicative. Upon rectal palpation, the uterus appears doughy, thickened, and enlarged. Fluid content can be revealed via ultrasound examination, which has an echodense appearance. Uterine lavage containing antibiotics should be administered immediately to flush the content out of the uterus. Further treatment is mainly

supportive and includes the administration of anti-inflammatories, systemic antibiotics, fluid therapy and prophylactic treatment of laminitis. Tetanus prophylaxis should be done in case the mare is unvaccinated to prevent puerperal tetanus [73].

A rare condition, uterine prolapse might occur directly after foaling or even several days later. Sometimes one of the horns or the body prolapse, and rupture of the uterine vessels, shock and ischemia can also occur and may have a fatal outcome. Careful examination and evaluation of the prolapsed fragment are crucial and control of straining. Administration of sedatives, epidural or general anaesthesia might be required. The prolapsed part should be cleaned thoroughly, tears should be sutured and if there are any bleeding vessels, they should be ligated. The whole content should be placed back to reduce the occurrence of re-prolapse. Antibiotics may be given to prevent infection and tetanus prophylactic measures should also be taken care of [73, 79, 84].

Other post-partum problems are trauma and lacerations of the perineal area, vulva, and vestibule. Inflammation of the vulva, vestibule and vagina to some extent is considered normal following parturition and usually resolves in a few days. Excessive tearing should be sutured to prevent bacterial contamination and infection, but first inflammation should be reduced. Further injury to deeper structures of the reproductive tract can be examined via palpation per vaginam. Perineal lacerations can be subdivided into three degrees. First is when the vulval lips are lacerated with only skin and mucous membrane involvement and can be corrected with Caslick's procedure. In second-degree lacerations, not only the superficial structures but the musculature is also affected, usually the constrictor muscles, thus the ability to close the vulva is hindered and pneumovagina may occur, which predisposes the mare to reproductive issues later on. In these cases, inflammation should be reduced first, then under sedation, the edges of the wound should be refreshed and sutured. Third-degree lacerations are the more severe, where the vaginal roof, rectal floor and the surrounding perineal tissues are all affected and injured. This condition occurs when the foot of the foal deviates dorsally through the roof of the vagina injuring the structures above. A recto-vaginal fistula may develop, which is basically a tunnel between the gastrointestinal and reproductive tract with continuous risk of faecal contamination and therefore infection. Antibiotics and supportive medication, such as anti-inflammatory agents are given to protect the mare from severe infection. The wound should heal by second intention with the formation of scar tissue. Following this, surgical correction of the area can be performed with the creation of flap tissue and Caslick-like closure. These mares usually cannot return to breeding season right away as they may need several attempts to repair the damaged area and till then mating should be postponed [79, 84].

There are some drastic complications, which are fortunately very uncommon but can happen. These are the ruptures of an area of the reproductive tract, such as the cervix, vagina, or uterus. The outcome of these conditions is variable as in some cases peritonitis develops rapidly and the mare dies soon. On the other hand, if the rupture is only to a small extent, it may heal by second intention and via conservative treatment. Others may require surgical correction, which is not always possible. These conditions are painful, and the mare might show signs of colic and depression [73].

Uterine haematoma is a relatively common condition and is when smaller uterine vessels and their branches rupture during heavy contractions. The blood flows between the layers of the myometrium and serosa. Haematoma formation is a self-limiting process, when enough blood fills the empty space, the pressure created will induce haemostasis. The prognosis is good in such cases [73].

Internal haemorrhages on the other hand are fatal in most mares. It occurs when one of the major arteries, such as the uterine or utero-ovarian artery ruptures. The only signs are distress, and colic, with gradually worsening anaemia. Treatment options would be blood transfusion and elimination of shock, however, the prognosis is poor [73, 79, 84].

4.12. Post-partum events

Uterine involution means the re-establishment of non-gravid uterine characteristics. Following labour, the myometrial contractility again increases and is driven by the oestrogen effect when returning to oestrus, which occurs in 5-7 days post-partum. Also, the placenta secretes progestogens and relaxin, which minimize contractions and when it is expulsed these hormones no longer have an influence on the uterus. The direction of contractions is towards the caudal direction, thus from the uterine horns towards the cervix, allowing the expulsion of fluid, debris, and bacteria, thus facilitating clearance. The uterine involution of the mare is a rapid process as foal heat takes place within 15 days after foaling and is usually a fertile heat. The complete process takes about 21 days and is required for the establishment of a new pregnancy. Assessment of uterine involution can be performed manually via rectal palpation, or per vaginam, and via ultrasound. In case uterine involution is disturbed or there is a prolonged uterine infection still, the mare should not be covered in foal heat as the conception rate is reduced and also increases the risk for complications, such as early embryonic loss [73, 85].

4.13. The lactating mare and the young foal

4.13.1. Foal adaptation in the periparturient period and management of neonates

Immediately after foaling, the neonate should start to adapt to the extra-uterine environment via anatomical, functional, and biochemical changes for survival. The first few days are critical and require close monitoring to detect any abnormalities and to be able to intervene and help the foal to survive. When the foal is born it usually lays on its side and critical values such as heart rate, and respiratory rate can be measured. Respiration should start within the first 30 seconds to 1 minute and it may initially be sharp breaths. Within or after the first-minute, rhythmic intentions of breathing should be established with a rate of 60-70 per minute. Literature suggest that the tidal volume of these breaths is approximately 520 ml, resulting in a minute volume of 35 litres. Rapid breathing results in the marked increase in the level of oxygen in blood. 40-80 beats per minute are the normally accepted range for heartbeats. Rectal temperature ranges between 37.5-38.5°C in the newborn foal. In a few hours, the respiratory rate decreases to 35/min, while the heart rate increases to 120-140 beats and then decreases to 80-100/min within a week. After a few minutes, the foal should change its position to sternal recumbency with evidence that it is conscious of its environment. As it was mentioned in previous chapters, the umbilical cord after parturition is still intact and should break naturally to prevent extensive blood loss. This event takes place within 10 minutes after foaling, usually when the foal starts to have muscle reflexes and begins attempts to move. The navel should be disinfected with chlorhexidine or betadine. The foal must try to attempt to stand on its feet within 35 minutes with some unsuccessful tries made the preceding victorious attempt and this rapid ability to stand has evolutionary reasons, as they must be able to flee from predators within a short period of time. Thoroughbred foals may require an hour to stand on their feet according to literature [86]. After two hours of failed attempts veterinary care should be considered as it is indicative of abnormalities. The mare lay and rest for 40 minutes to an hour, while the foal will direct toward her mother and try to find the udder and suckle. This process shall not be intervened, a bond between the dam and its foal is developing at this stage. Healthy suckling reflex can be monitored. The foal in its first few days of life will suckle in every 30-60 minutes then the interval lengthens. Meconium is the first intestinal content of the foal and should appear in the first 12 hours. Sometimes it has already been passed during labour, which is indicative for foal distress. It consists of the glandular secretions of the intestines from intrauterine life and also contains the digested amniotic fluid and debris and has greenish-brownish colours. Urination also occurs twelve hours post-partum and the colourless appearance of it is considered normal. These above-mentioned events are the part of the anatomical adaptation of the foal. Functional

adaptations consist of the pulmonary ventilation, development of the circulatory and cardiac systems and also the regulation of temperature and the immune status. Functional and structural maturation of the lungs rely on the surfactant maturation within uterine life. For the transfer of gases in the lungs and the air-blood interface, surfactants are crucial as they provide a surface film, thus relieving tension and preventing the lungs from collapsing. In premature foals, respiratory efficiency is disturbed. There is an oxygen-poor environment in the lungs at parturition, as the foal takes its first breath at that time. This event triggers the foal to breathe following parturition to decrease plasma carbon dioxide levels and fills the lungs with oxygen under normal conditions. Expansion of the lungs and development of the alveoli continue. As breathing efficiency increases, respiratory rate decreases. When the foal takes its first breath after birth, the lungs are expanding, thus creating reduced pulmonary resistance. This results in the increased perfusion of blood to the lungs. In the womb, the placenta replaces the function of the lungs and via the structure called ductus arteriosus, the blood bypasses the pulmonary system. The foramen ovale is another structure responsible for blood flow between the right and left atrium, which also enables to bypass the pulmonary system. Reduced pulmonary resistance is thought to be responsible for bypassing the ductus arteriosus following birth and the blood flows through the pulmonary vein. The left side of the heart is filled with the increased amount of blood from the pulmonary artery, which will elevate the blood pressure to an extent where it creates greater pressure on the left side compared to the right, thus the closure of the foramen ovale. Closure of the ductus arteriosus should happen a few days following parturition. Abnormal or no closure of the duct results in stress and hypoxaemia. Foals are known to have a very effective controlling ability of their body temperatures and have a high metabolic rate, which is advantageous in neonate life. The immune status of foals is relatively low due to the thickness and type of the placenta, as immunoglobulin passage is limited through it in utero. Antibodies, therefore, passed through the colostrum of the mare and are vital for foals. There are three types of immunoglobulins in the horse which are as follows: IgG, IgM, and IgA. Within one day, the enterocyte lining of the small intestine is able to absorb these large molecules, therefore it is crucial for the foal to receive adequate quality and quantity of colostrum within this period of time, preferably within twelve hours. The colostrum of the dam can be evaluated based on its specific gravity and over 1060 is indicative of adequate immunoglobulin content and the foal should receive a minimum of half litres. Energy reserves of the foal are derived from liver glycogen stores and are quickly depleted. Milk contains glucose as an energy supply for the foal and therefore suckling in the first few hours of life is crucial for vitality. When assessing the vitality of the foal, these parameters should be

monitored, and any deviation present may require veterinary care. First hour is critical to evaluate as time passes, the foal has a limited chance of survival even with the right intervention. The mare and its foal should be kept in a clean, dust-free, and sharp object free environment [86, 87].

In some studs, prophylactic administration of antibiotics is performed as a part of routine management of the neonatal foal, however literature suggests controversial data. In mares and foals with suspected infections or poor keeping conditions may justify the administration of antibiotics, even though good management and keeping cannot be replaced with it. Vitamin injections, including vitamin A, D and E and selenium are also routinely given in some studs. Application of these products however, only justified if the mare is known to be deficient in these [73, 88].

If parturition took place in a box or a designated area for foaling, the foal and its dam can be put to a small pasture or paddock after three days. Preferable conditions include a sunny, dry day and the area should be free from sharp and dangerous objects. The foal can be introduced to solid concentrates after three days. Gradually roughage and hay can also be introduced. The milk of the dam is covering the requirements of the foal as long as 6-8 weeks [86].

4.13.2. Management of the post-partum mare

The mare should be left with its foal post-partum to be able to bond her offspring. Clean bedding, dust-free environment, good quality hay and fresh water should be available. She may rest for another 40 minutes to an hour following parturition before standing up again. Then she will allow the foal to suckle. After 72 hours post-partum, the mammary gland secretes milk instead of colostrum. The mare should be carefully monitored for any signs of disease, such as fetid discharge from the reproductive tract, lethargy, fever etc. Evaluation of udder and milk production is done via monitoring the foal. There might be a transient agalactia, which usually resolves in a few hours following parturition and may be helped with the administration of oxytocin as it helps milk let-down. If there is a persisting agalactia, the foal should be considered as an orphan and immediate intervention is needed to either find another lactating mare or artificially supply its needs. Mastitis is a relatively rare condition in the mare and mostly occurs following weaning. If happens at the periparturient period, this milk should not be given to the foal. Nutrition-wise the lactating mare has higher requirements than the non-lactating mare and even increases with 75%. Therefore, the nutrition should focus on the energy, protein, vitamin, and mineral requirements of the lactating mare and adjusted accordingly. Any deficiencies in the mare will also affect the foal. Gentle exercise of the mare has an

advantageous effect on uterine involution of the mare. There are no specific immunisation requirements for the mare following parturition in case it was done before and during pregnancy. Those protocols should be followed. Mares can be dewormed in the first week after parturition in highly infested areas, as parasites may affect the foal too [86].

5. Materials and methods

First of all, I tried to collect and study good quality and reliable literature and research resources to be able to summarise the most important pillars of my Thesis. In the meanwhile, I actively attended at the Stud to monitor and evaluate the control processes of Thoroughbred breeding. All available data were gathered and collected from 2017-2023 about the coverings, pregnancy, parturition and post-parturient period of mares and foals at Sárbogárd-Mindszentpuszta from hand-written notes of Melinda Hajba, the Stud Manager, and from breeding records, provided by the Hungarian Gallop Racehorse Breeders Association. Then all of the data were imported into the Microsoft Excel software, where it was further subdivided and selected based on the selected criteria and were also added to the Thesis at Appendices chapter (Chapter 11.). The most important questions and data were organised into tables and graphs for better understanding and transparency. The questions are mainly focusing on the literature review findings and the results are comparable to those.

In the end of the Thesis, I tried to represent and evaluate these above-mentioned data that were available and draw conclusions and suggest further questions to be investigated in order to improve reproductive efficiency and foaling rates in the stud.

6. Results

For the manipulation of the oestrus cycle in broodmares in the Stud different techniques and hormones applied. An interview with the Stud Manager was done to investigate the methods applied. Broodmares are on pasture during the day and depending on the season, they are herded to individual boxes for the night, where additional illuminated hours are provided for them. Administration of hormones is upon the decision of the veterinarian and the Stud Manager together. Prostaglandin is administered if luteal phase is to be shortened because the previous cycle could not be used for breeding. Ovulation of a large follicle is induced with hCG, then the mare is covered in 1-2 days. Sometimes, when twins are located in the same horn or being too close to each other and manual reduction cannot be performed, prostaglandin is administered to terminate the pregnancy and the mare is covered again at the next cycle.

Stud Manager was also asked whether their goal is to cover the mares the closest to the start of the operational breeding season (15th February). According to her, foaling in January in this Stud is not too preferential due to the weather conditions and adverse effects originates from it. Experience of previous years shows, that their reproductive efficiency, foaling rates and health of the foals are better if they are not too strict with attempted covering in February. Not to mention the fact, that administration of hormones to induce cycling earlier in the year is an enormous expenditure if performed on a regular basis among broodmares. Therefore, covering of the mares start a bit later in the Stud, around the end of February and beginning of March, thus foaling season is delayed with a few weeks and thereby adapting to the natural breeding- and foaling seasons.

In Table 1. data about the time frame of matings and parturitions were collected and also interval and average of gestation lengths were calculated using Microsoft Excel software, then converted into a summary table.

Number of covering shows a gradually decreasing number since 2017. First and last covering of mares had been between the operational breeding season in all years. Foaling season started earliest in 2019, when the first foal born on the 6th of January. Latest born foal in the foaling season was in 27th of May in 2022. The minimum gestation length was 308 days in 2023, where the foal survived, even though it was premature. Out of 167 examined gestation lengths, 364 days was longest, which gave a healthy foal. Average of gestation length is showing a decreasing tendency and is approximately 329-336 days.

	Number of Covering	First Covering	Last Covering	First Parturition	Last Parturition	Gestation length (min-max)	Gestation length average
2017	56	03.01.	06.03.	01.19.	05.19	314-364	335
2018	64	02.25.	06.15.	01.06.	05.21.	315-354	335
2019	50	03.20.	06.12.	02.16.	05.20.	316-347	334
2020	27	03.02.	06.15.	01.21.	05.21.	321-348	332
2021	28	02.16.	06.25.	02.01.	05.27.	321-357	336
2022	31	03.06.	05.06.	01.30.	-	308-345	329

Table 1. Covering, parturition and gestation length from 2017 till 2022 (source: hand-written notes of Melinda Hajba)

In Table 2. six years of data were summarised to investigate all number of coverings, where one mating per cycle per mare was counted for better understanding and also parturition was written in the same row as covering, even though it represents the next consecutive years. All together 256 mares were covered from 2017 till 2022, and these mares will be the base of evaluation of this study. Out of 256, 165 (165/256, 64%) mares had a foal and there are 5 who still have not foaled yet and 2 were sold, therefore results cannot be concluded from these 7 mares. From 2018 till 2023 there were 16 (16/256, 6%) confirmed twin pregnancies. Detected number of early embryonic death (EED) or absorption before day 40 were all together 12. Out of 84 "empty" mares, which did not have a foal in the consecutive year, only 13 had a diagnosed cause, including EED or absorption and death of the mare. 71 of 84 (71/84, 84,5%) mares remained unknown of why being empty and were attempted to be covered several times during the breeding season. Number of foals detected to be premature was 3, out of which 2 passed away soon after birth and one survived. Abortion happened in 5 cases, out of which none gave a definite diagnosis according to the Stud Manager. Out of 5 abortions, 2 mares were confirmed to have twins, but they were managed either by manual crushing or absorbed in utero. Out of 165 foals, there was only one with diagnosed congenital defect. This foal was born at term, approximately at day 343 with un- or underdeveloped genital and urinary tract and lived for only 5 days. Out of 165 foalings, 3 (3/165, 2%) involved difficult delivery or dystocia with required assistance of more than one personnel. Two of the foals died in utero and one passed away soon after, which reported to be stuck at the birth canal and possibly had broken bones and internal damage. One of the mares had uterine rupture during labour and had internal bleeding with a fatal outcome.

	Covering	Parturition (next year)	Empty	Twin	EED	Abortion	Premature	Stillbirth	Dystocia	Congenital defects
2017	56	35	21	0	2	0	0	1	1	0
2018	64	42	22	5	4	2	0	0	0	0
2019	50	33	17	6	2	1	1	0	0	1
2020	27	18	9	1	1	1	0	0	1	0
2021	28	21	7	2	2	0	0	1	1	0
2022	31	16 (+ 5 have not foaled yet + 2 sold)	8	2	1	1	2	2	0	0
Total	256	165 (+7 unknown)	84	16	12	5	3	4	3	1

Table 2. Summary of data between 2017-2023 (source: hand-written notes of Melinda Hajba)

Diagram 1. represents the number of twin pregnancies and also their outcome. All together there were 16 twin pregnancies from 2017 till 2022, out of which 8 (8/16, 50%) carried a healthy foal to term after manually crushing or randomly absorbing one of the twins. Interestingly, there was one mare with 3 embryonic vesicles detected. Two of them were situated in the same horn, thereby those were decided to be crushed manually. The other one was born alive and healthy in 2020. From 5 abortions, 2 were twin pregnancies, out of which one was crushed manually and the other one was only suspicious for twins. There was one case of stillbirth of both twins. Manual crushing was performed around day 40 of gestation, which turned out to be unsuccessful. There were two twin pregnancies (2/16, 12,5%), which were confirmed and decided to manually reduce one of them. In both cases the other twin was absorbed soon after crushing their twin. These mares were covered again and had a healthy foal in the next foaling season. Termination of pregnancy was carried out in 2 cases (2/16, 12,5%) because these twins were situated within one horn and none of them absorbed till repeated examination. Manual reduction was not feasible due to them being too close to each other and thereby risking pregnancy anyways.

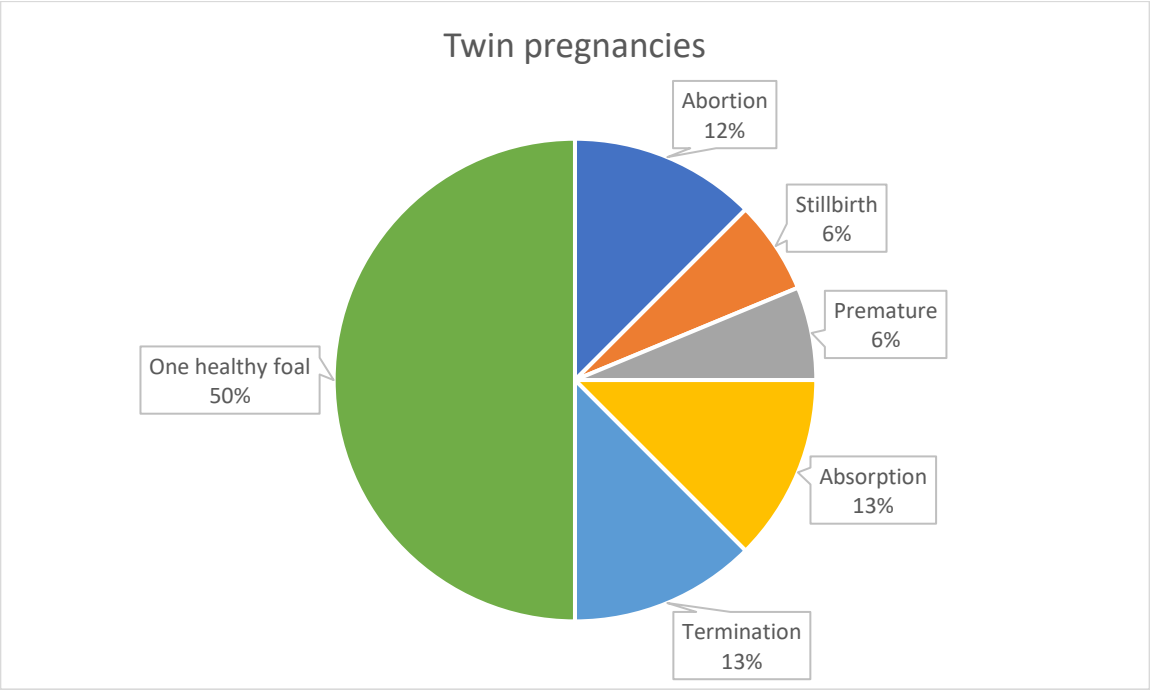

Diagram 1. Twin pregnancies from 2017-2022 (source: hand-written notes of Melinda Hajba)

Data about foals in between 2018 and 2023 were collected and categorised into Table 3. Total number of foals born is 160 and is showing a gradually decreasing number over the years. There were 4 foals born weak, out of which 1 had to be euthanised, 2 passed away before one months of age due to general weakness and purulent polyarthritis. The last weak foal was born premature and died shortly after birth, therefore all weak foals (4/4, 100%) passed away soon after birth. There were 2 orphan foals due to their dam passing away because of colic. 2 out of 2 (2/2, 100%) orphans survived. In 2022, there was two foals diagnosed with Rhodococcus equi infection, out of which only one (1/2, 50%) could be treated.

Throughout six years, only 4 foals had to be euthanised (4/160, 2,5%) due to them suffering from an accident or being weak and guarded vitality. There was one mare in 2023, which showed aggressive behaviour towards her foal and ended up killing the newborn via kicking injury.

	Number of foals	Stillbirth	Premature	Weak	Orphan	Rhodococcus equi	Euthanasia or passed away
2018	35	1					3
2019	40				1		0
2020	32		1	1	1		4
2021	17			2			3
2022	21	1				2	2
2023	15	2	2	1			4
Total	160	4	3	4	2	2	13

Table 3. Data about foals born in between 2018-2023 (source: hand-written notes of Melinda Hajba)

Mares after parturition enter their breeding season and therefore covered again as soon as they are showing oestrus behaviour. 46 broodmares were collected from the Excel sheet, which had been covered shortly after parturition, to examine at which cycle they were bred again. All together 83 parturition and covering interval were gathered. A simple calculation was made in Excel Software, where the date of parturition was subtracted from the date of the first covering afterwards. Average days in between parturition and first covering was 39 with a minimum of 5 and maximum of 126. All intervals are illustrated at Diagram 2.

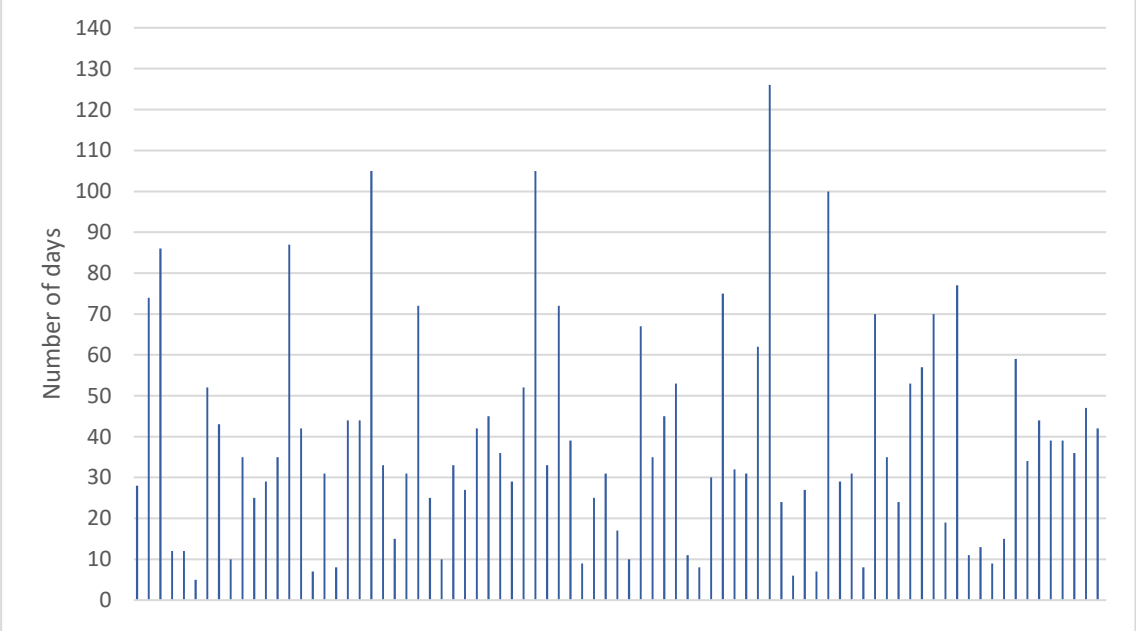

Diagram 2. Number of days from parturition till next covering in 83 examined cases (source: hand-written notes of Melinda Hajba)

Diagram 3. illustrates the distribution of matings based on which oestrus were used for the first fertile mating out of which a foal born in the consecutive year. Calculation the number of cycles was made on the hypothesis that foal heat occurs within 15 days after parturition and every cycle had an interovulatory interval of 21 days. Mating at foal heat was successful in 19 cases out of 83 (19/83, 23%). In 30 cases the second heat was fertile or had been used to breed the mare again (30/83, 36%). At 34 occasions only the third or later heat period were eligible for covering the mare (34/83, 41%).

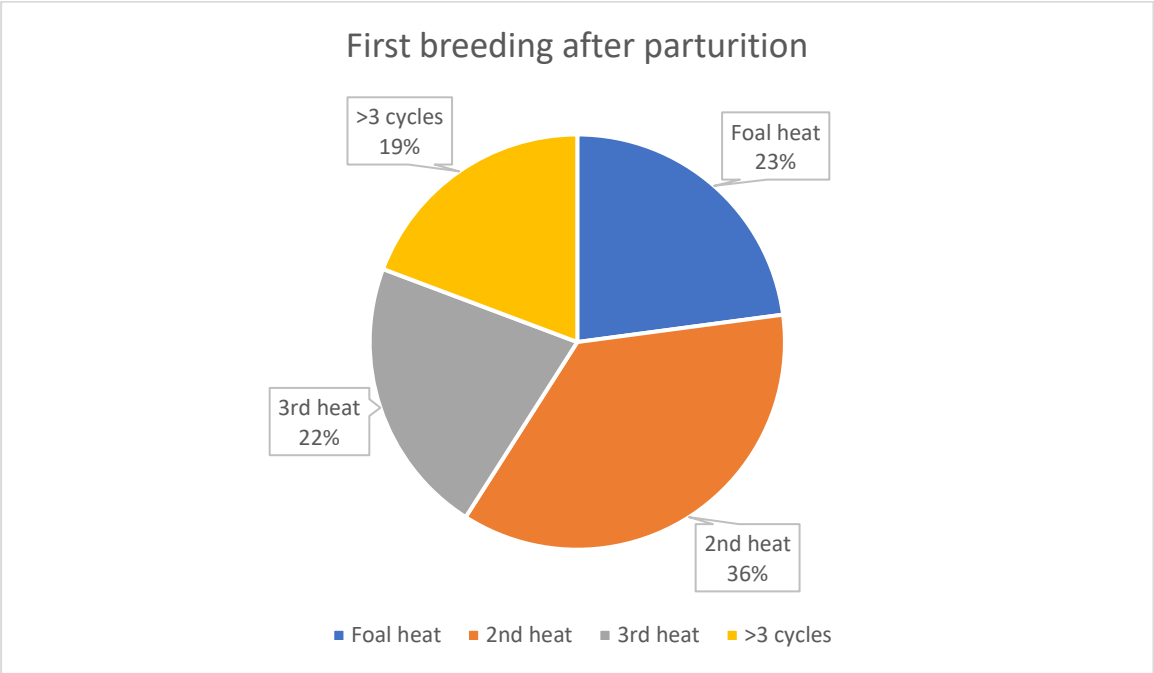

Diagram 3. Distribution of matings based on cycles (source: hand-written notes of Melinda Hajba)

In the end of the interview a few questions were asked from the Stud Manager, Melinda Hajba, about the preventive measures and protocols at the Stud. Deworming of all horses, including stallions and broodmares are carried out in every 3-4 months with ivermectin, praziquantel and fenbendazole in turns. Foals are dewormed in 2.5 months of age first, then every 2 months till 8 months of age. According to her, deworming protocol seems to be reasonable, and results are satisfactory as there were no known high parasitic infestations which resulted in sickness and chronic illness of these horses. Vaccination protocols are also carried out in each broodmare and stallion at the Stud. Following basic immunisation, twice yearly administration of Equine Influenza vaccine is done. Tetanus prevention is performed every six months following basic immunisation and administered one month before parturition in broodmares. Vaccination against Equine Herpes Virus 1 and 4 is performed every half a year in non-pregnant mares, then

for pregnant mares vaccination is carried out at 5-,7-, and 9 months of gestation period. Additional vaccines, such as Rabies and West-Nile Virus are also given if the Stud Manager and the veterinarian find them reasonable. In the previous decade, there was no confirmed case of the above-mentioned infectious diseases.

Questions were also asked regarding the care of the new-born foal and the mare. Colostrum of the dam is measured with colostrometer, evaluating the specific gravity, which is adequate if level is above 1060 g/L. Following labour, the general health status of both the mare and the foal is monitored. Umbilical cord stump of the foal is disinfected with iodine and with spiritus pyoctanini 5% solution. Temperature of the foal is measured as a general routine every morning. If the foal has fever, broad spectrum antibiotics are administered for prevention. The mare and the foal can go out to an individual pen after 10 days respectively, then they are grouping them with 3 mare and foal pairs. Foals are also supplemented with special feedstuff designed for them. Mares are grazing on pasture and additional good quality hay and if needed, grains are given. Foals are weaned and transported to Bácsalmás at 6 months of age, where they are trained for racing later. Mares are examined by the veterinarian after foaling to access the state of uterine involution. Retained foetal membranes are treated with anti-inflammatories, antibiotics and with uterine lavage if needed.

7. Discussion

The main goal of this Thesis was to gather relevant information about Thoroughbred breeding, pregnancy, and parturition, and also about periparturient events. After gathering relevant research on these periods, I tried to collect and evaluate the data available at the Thoroughbred Farm using Microsoft Excel Software and comparing practical findings to the literature.

Even though operational breeding season in Hungary starts at 15th of February, the examined mares were not covered this early in the season, but rather a few weeks later, which decreased the expenditure of the company, hence decreased amount of hormone therapies were performed with this regard. Hormones were only used for the purpose to induce cycling later in the season or to terminate twin pregnancy in cases, where were indicated. Data about hormone therapies were not available in sufficient number of cases, therefore this Thesis is not concluding anything from these findings. Further research is necessary to investigate the effectiveness and relevance of these protocols applied at the Stud.

According to the results at Table 1. the average gestation length of Thoroughbreds at the Stud varied between 329 and 336 days, which confirms the findings in the literature review (Chapter 4.6.). Only one pregnancy exceeded 360 days, thus being overdue, but a healthy foal was born at day 364. Based on the results, it can be concluded that mares are rather give birth earlier than later, which might give the chance to also conclude that this way the foals are not over-sized, which decreases the chance of dystocia and abnormalities in foaling. Further research would be needed to examine the factors that trigger the time of parturition, whether the gender of the foal, the timing of the year and other factors which are related to the gestation length of horses.

From 2018-2023 165 mares had a foal out of 256 matings, which is 64 % from all coverings. From the results it can be concluded that these Thoroughbreds have a relatively poor reproductive efficiency as 84 cases out of 256 (84/256, 33 %) of all covered mares remained empty regardless of repeated breedings and hormone therapies applied.

In six breeding- and foaling seasons only 16 (16/256,6 %) of the mares had confirmed twin pregnancies, out of which 8 (8/16, 50%) carried one foal to term, the rest either absorbed both, aborted or had stillbirth. It can be concluded that twin pregnancy in Thoroughbred is somewhat common, but as research suggest it should be managed in all cases because it does affect foaling and also can be a cause of abortion (2/16,12,5%), stillbirth (1/16, 6%), premature foal (1/16,6%) and dystocia, which are not preferential in any animal breeding industries and is dangerous for both the mare and the foetus.

Early embryonic death (EED) was detected in 12 cases (12/84, 14%). Low number of detected cases gives rise to confirm research findings, that diagnosis of this condition is challenging, as

mares are only examined around day 10-12 of gestation at earliest, therefore the findings only represent EED cases in between day 10-40. There are no results available on EED before day 10 and also the number of empty mares is relatively high, being 84 out of 256 coverings (84/256, 33%). In the future, further detailed examination of empty mares is required to evaluate the prevalence of early embryonic death and other causes.

Abortion in the stud is low, being only 3% (5/165), as well as premature foals (3/165,2%) and congenital defects (1/165, 0,6%). None of these cases revealed definite diagnosis despite being investigated, but contagious causes were excluded.

Dystocia was attempted to be managed on 3 occasions, which is low (3/165, 2%). Mortality rate of these cases were 100% (3/3). 2 of these detected cases were stillbirth and dystocia together out of which one resulted in the death of the mare as the uterus ruptured. In the other case, the foal appeared in the birth canal with two forelegs and one hindlegs. Upon assistance, the foal was attempted to be pushed back and repositioned, but it was born unalive. On the third occasion the foal reported be stuck at the birth canal, born alive with assistance but passed away soon after birth. Questions were related if there was any other case where assistance was required to reposition the foal. Workers at the stud claimed that they only assisted if the mare was exhausted but there was no other recorded case of dystocia where more than one personnel was required. Based on the finding it can be concluded that dystocia among these Thoroughbreds is uncommon, even though if present it is very difficult to manage without either harming the mare or the foal. Caesarean section and foetotomy were not performed in any occasions.

Out of 160 foals born from 2018 till 2023, 13 (13/160,8%) passed away or had to be euthanised. All foals that found weak passed away (4/4, 100%), which indicates that low vitality has adverse effects and incompatible with long-term survival. Orphan foals are relatively uncommon in the Stud (2/160, 1,25%) and their chance of survival is great (2/2,100%). Accidents are extremely rare, there was only one case, which indicates that management of foals and their dam is excellent in this regard. Aggressivity of mares towards foals is also rare among these broodmares, even though there was only one case with a fatal outcome. This kind of behaviour is difficult to be interpreted and the goal should always be to keep the foal and the dam together. There were 2 cases of bacterial infection of Rhodococcus equi in the stud, out of which one foal were diagnosed and treated on time, but the veterinarian recommended to exclude this foal from racing as complications of the disease results in decreased performance in most cases. The other foal passed away despite of treatment. Antimicrobial resistance revealed guarded results, as the bacteria were resistant to all examined antimicrobials. Further research would be advantageous

to reveal the use of antimicrobials in the Stud and to examine their relevance to be part of the prophylactic protocols.

83 cases were selected from all coverings to examine the prevalence of foal heat fertility and to reveal information on breeding after foaling. The criteria were only that the mare did not remain empty in the year at foaling. Average days in between parturition and next consecutive breeding resulted to be 39 days, which means that on average the second heat after foaling is appropriate for breeding. Results confirm research findings. Foal heat in the mare was hypothesised to take place within 15 days post-partum. In 19 cases out of 83 (19/83, 23%) were successful, therefore uterine involution can be concluded to be successful on time in these cases. In 30 cases (30/83, 36%) second heat was attempted for covering and resulted in the development of pregnancy. It can be concluded that more than 50% of the mares were able to be bred within 2 cycles. There were no data available, whether foal heat was not attempted to be used or were not successful. Further data collection is required to reveal the background of these results.

Preventive measures at the Stud are performed according to protocols recommended in recent literature. The effectivity of these vaccinations, deworming protocols can be confirmed as there were no detected cases of these diseases and infestations.

8. Summary

This study attempted to fill a gap in statistical analysis and collection of data of control and management of Thoroughbred breeding in Hungary on the representation of findings at Telivérfarm Kft. Thesis revealed that upon the establishment of pregnancy, foaling rates are good and management of foals and mares after foaling is appropriate and trying to keep up with recent research and protocols. Breeding management, however, should be advanced in order to achieve higher conception rates in the future as it is estimated to be 64%. Most of the data that were gathered was only available in hand-written format, digitalised version was performed to be able study and evaluate all available data at the farm for the first time since the establishment of the Stud. Further investigation on a larger extent is suggested to be carried out in the future to gather a better understanding and to be able to give further exact recommendations designed exclusively for this Stud.

All data, results, evaluations, and conclusions obtained in this Thesis are provided for the management of the Stud and I am hoping to be able to investigate this field further in the future.

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11. Appendices

Mare	Stallion	Covering	Parturition	Foal Name	Gender	Other		
Zelnike	Makaam	2017.03.16-18	2018.02.12	Zenrikó	male			
Xindi	Makaam	2017.05.08-11	2018.04.04	Xindikátus	female			
Szonáta	Makaam	2017.05.13-18	2018.04.14	Szokatlan	male			
Színarany	Makaam	2017.04.29-05.04	2018.03.30	Színtiszta	female			
Sunny Vale	Makaam	2017.03.30-04.02	2018.03.12	Sunny's Ló	male			
Szuvenír	Makaam	2017.04.21-22	2018.03.21	Souvlaki	male			
Should I Stay	Steady As A Rock	2017.03.15-18	2018.02.16	Shoester	male			
Sarkcsillag	Steady As A Rock	2017.05.02-07	2018.03.28	Sarkszikla	female			
Sansz	Makaam	2017.03.20-21	2018.03.20	San dOr	male			
Samirza	Makaam	2017.04.24-27	2018.03.21	Samilla	female			
Ravenna	Makaam	2017.05.09-11	2018.04.11	Római lány	female			
Qmisz	Steady As A Rock	2017.05.13-14	2018.04.13	Qsz Qsz	female			
Qba	Rendezvous	2017.03.24-28	2018.03.05	Qba Libre	female			
Nük	Makaam	2017.04.04-14	2018.03.16	Nüansz	female			
Ncore	Steady As A Rock	2017.03.04-05	2018.02.13	Nicore	male			
Naraan	Steady As A Rock	2017.03.11	2018.03.01	Narrock	male			
National Art	Makaam	2017.03.05-09	2018.02.13	Nakaimo	female			
Mirtuszlány	Makaam	2017.03.26-29	2018.02.20	Mirtuszlevél	male			
Mezzaine	Rendezvous	2017.03.30-04.06	2018.02.16	Mezzoforte	female			
Hírnév	Satin Stone	2017.05.28-06.03	2018.05.19	Hírös	male			
Finálé	Esti Csillag	2017.03.01-02	2018.01.19	Finish	male			
Estemona	Steady As A Rock	2017.04.03-06.	2018.03.13	Estepone	male			
Éjkirálynő	Satin Stone	2017.04.02-05	2018.02.26	Éji Láng	female			
Dynamite Blond	Esti Csillag	2017.05.13-14	2018.04.14	Draco	male			
Dirty Dreamer	Steady As A Rock	2017.05.09-11	2018.04.28	Dirty Dancer	male			
Crimson	Rendezvous	17.05.08.-2017.05.15.	2018.04.16	Criminális	female			
Celesta	Satin Stone	2017.04.27-28	2018.03.26	Cecey Éva	female			
Brahy Lánya	Atheneum	2017.04.21-22	2018.03.29	Bratheneum	male			
Béke	Satin Stone	2017. 03.20-25	2018.02.14	Békesség	female			
April's Music	Makaam	2017.06.02-05	2018.05.01	Április Boldo	female			
AmeRéka	Satin Stone	2017.03.07-16	2018.03.04	AmeRita	female			
Apple Pie	Esti Csillag	2017.04.14-17	2018.03.20	Almacsillag	male			
Nádbuga	Atheneum	2017.05.18-19	2018.04.03			foal euthanasia	2018.05.29	Accident
Cherish	Steady As A Rock	2017.03.26-28	2018.03.13			Dystocia+ Stillbirth	foal-stillbirth mare-uterine rupture	2018.03.13
Hildene	Esti Csillag	2017.05.29	2018.04.30			foal died	sent to patho-result-inconclusive	

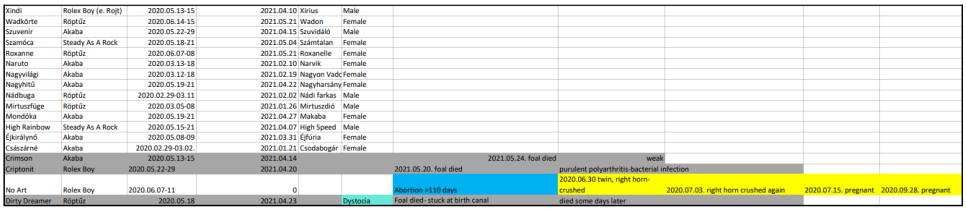
Excel sheet 1. Breeding season of 2017

Zelnike	Esti Csillag	2018.03.01-03	2019.01.31	Ziccer	Male				
Zara	Category Five	2018.04.11-23	2019.03.21	Zagyva	Male	twin	2018.05.31: right horn absorbed, body pregnancy	2018.06.11: pregnant-one	
Xindi	Makaam	2018.05.05.-05.07	2019.03.20	Xinonima	Male				
Szuvenír	Röptűz	2018.03.30-31	2019.03.01	Szufla	Female				
Szibilla	Steady As A Rock	2018.03.21-23	2019.02.28	Szibill	Female				
Szamóca	Esti Csillag	2018.03.21-22	2019.03.02	Szamos	Male				
Should I Stay	Steady As A Rock	2018.06.01	2019.04.21	Sudoku	Female				
Szonáta	Steady As A Rock	2018.05.23-24	2019.04.29	Sorento	Male				
Színarany	Out Loud	2018.06.10-11	2019.05.05	Sín Lee Loh	Male	04.10. hCG, 05.04. hCG	EED from covering in May	06.05. PG, 06.09.hCG	successful rebreeding
Sharon's Stone	Category Five	2018.06.01	2019.05.10	Shanzon	Male				
Sarkcsillag	Category Five	2018.04.26	2019.04.05	Sha Chi	Male				
Sansz	Category Five	2018.04.25	2019.03.21	Sansztalan	Male				
Sarkkör	Rendezvous	2018.03.16-24	2019.02.26	Sakk Matt	Female				
Regős	Esti Csillag	2018.06.14-15	2019.05.14	Reggeli Csilla	Female				
Rózmarin	Steady As A Rock	2018.03.16-18	2019.03.02	Ready As A R	Male	twin	2018.04.04. left 1cm , right 2,7 cm	2018.04.10: left absorbing 1 cm, right 3 cm	2018.04.17. right horn pregnancy
Ravenna	Category Five	2018.05.08-13	2019.04.03	Raven	Female				
Qmisz	Makaam	2018.05.16-17	2019.04.17	Qzin	Male				
Queen's Night	Esti Csillag	2018.03.16-18	2019.02.22	Queen's Mo	Female				
Qltúra	Out Loud	2018.03.28-03.03	2019.01.31	Qltusz	Male				
Nük	Category Five	2018.04.10-16	2019.03.17	Nix	Female				
National Art	Esti Csillag	2018.02.28-03.11	2019.02.14	NeseNelly	Female				
Ncore	Makaam	2018.03.16-24	2019.02.28	Ncobo	Male				
Naruto	Steady As A Rock	2018.04.05-08	2019.03.05	Naru	Female				
Naraan	Steady As A Rock	2018.06.14-15	2019.05.17	Narangba	Male				
Nádbuga	Esti Csillag	2018.04.11-12	2019.03.16	Náder	Male				
Mezzanine	Out Loud	2018.03.30-04.01	2019.02.15	Metatron	Male				
Irish Edge	Out Loud	2018.04.26-30	2019.03.31	Irdatlan	Male				
High Rainbow	Rendezvous	2018.03.23-26	2019.02.22	Hidegtelió	Female				
Finálé	Esti Csillag	2018.02.23-25	2019.01.06	Fiasko	Female				
Éjkirálynő	Röptűz	2018.03.27-04.02	2019.02.28	Éjkirály	Male				
Dirty Dreamer	Steady As A Rock	2018.05.23-29	2019.05.06	Dirty As A Ro	Female				
Császárné	Out Loud	2018.04.08-10	2019.03.10	Császárkörte	Female				
Crimson	Steady As A Rock	2018.06.07-11	2019.05.21	Crupie	Male	2018.05.13. twin left crush	other absorbed too	2018.06.05. PG	rebreeding
Criptonit	Out Loud	2018.03.16-18	2019.03.07	Crix Crax	Male				
Brahy lánya	Makaam	2018.04.28-05.03	2019.04.10	Brandon	Male				
Béke	Esti Csillag	2018.02.24-26	2019.01.17	Békecsillag	Male				
April's Music	Steady As A Rock	2018.05.12-13	2019.04.15	Áprilisi Vihar	Male	twin suspicious	2018.05.31: left absorbed, right ok	2018.06.08. pregnant	
AmeRéka	Steady As A Rock	2018.05.16-17	2019.05.01	Amigo Mio	Male				
Apple pie	Out Loud	2018.06.11-14	2019.05.20	Almaszósz	Male				
Mirtuszlány	Röptűz	2018.03.23	2018.10.17			Abortion	sudden	pathology-sampling	
valeriana	steady as a rock	2018.04.18-19	2019.03.16			2019.05.02. Euthanasia Mare-colic	Orphan foal		
nagyhitű	out loud	2018.03.30-04.05.				abortion in between day 60-190	in between 2018.06.08-10.09		

Excel sheet 2. Breeding season of 2018

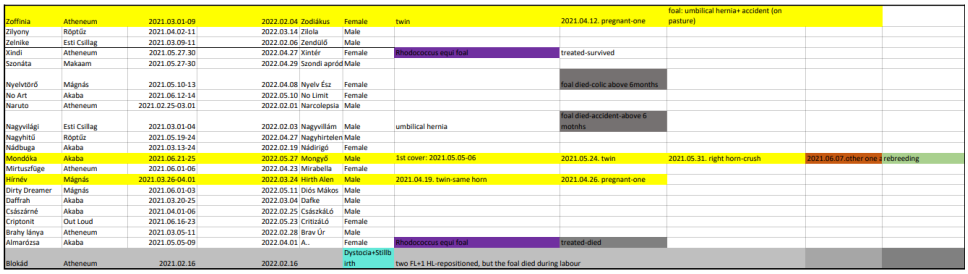
Zelnike	Out Loud	2019.03.25-31	2020.03.04	Zelda	Female				
Xindi	Röptűz	2019.04.13-14	2020.03.15	Ximpátia	Male				
Vincencia	Steady As A Rock	2019.03.28-04.14	2020.03.13	Vinka	Female				
Szuvenír	October	2019.04.05-16	2020.03.16	Szivesség	Male				
Szamóca	Röptűz	2019.04.04-06	2020.03.09	Szamojéd	Male				
Sarkkör	Out Loud	2019.04.19-20	2020.03.14	Sarkvirág	Female				
Sarkcsillag	Out Loud	2019.04.13-14	2020.03.08	Sarki Fűszer	Male	2020.04.05. Mare-colic-died	orphan foal		
Rózmarin	Out Loud	2019.04.16-18	2020.03.21	Rozmikus	Male	twin right horn and body	right horn massage		
Ravenna	Steady As A Rock	2019.05.04-08	2020.04.02	Ravarrock	Female	2019.05.23. twin, one crushed	2019.05.27. again crushed	2019.05.31. pregnant-one	
No Art	Makaam	2019.04.14-20	2020.03.27	No Argumen	Male				
Ncore	Out Loud	2019.06.03-08	2020.05.07	Nico	Male	2019.04.04-06. outloud	2019.05.23. irregular vesicle, absorbing?	2019.05.31. absorbed	2019.06.08. rebreeding
Navigáló	Steady As A Rock	2019.04.16-18	2020.03.23	Navalla	Male				
Natalie	October	2019.03.20-24	2020.02.27	Natasha	Female				
Naruto	October	2019.04.07-14	2020.03.06	Narancsór	Male				
Nagyhitű	Mediplomat	2019.05.01-04	2020.04.05	Nagyszénás	Female				
Nádbuga	October	2019.03.22-26	2020.02.16	Nadály	Female				
Mondóka	Mediplomat	2019.05.16-18	2020.04.25	Mondavilág	Male				
Mirtuszfüge	Out Loud	2019.03.25-04.03.	2020.02.27	Mirtuszhang	Female				
Mezzanine	October	2019.04.18-19	2020.02.29	Mezzaluna	Male				
High Rainbow	Mediplomat	2019.05.20-22	2020.04.13	High School	Male				
Finálé	Steady As A Rock	2019.03.22-31	2020.02.16	Fortuna	Female				
Éjkirálynő	October	2019.03.30-04.01.	2020.02.21	Éjkirályfi	Male				
Dirty Dreamer	Steady As A Rock	2019.05.14-21	2020.04.29	Dörzsölt	Female				
Dynamite Blond	October	2019.03.31-04.04	2020.03.01	Dömdödöm	Female				
Császárné	Makaam	2019.03.20-21	2020.02.18	Csasztuska	Male				
Criptonit	Mediplomat	2019.04.19-22	2020.03.30	Criplomat	Female				
Celesta	Steady As A Rock	2019.04.19-20	2020.03.21	Celektív	Male				
Brahy lánya	Mediplomat	2019.05.25-30	2020.05.11	Brémai Muzs	Female				
April's Music	Out Loud	2019.05.20-22	2020.04.27	Áprilisi Móka	Male	3 vehem!!! Különleges	2019.06.06. 2 veicles-right horn: crushed		
Nemzeti összefog	Makaam	2019.06.07	2020.04.05			PREMATURE (303)- foal died	twin	left horn-crush	2019.06.08. pregnant
Wadkörte	October	2019.06.12	2020.05.20	343		Congenital abnormality: urinary and genital tract was not developed enough	2020.05.25. foal died		
Regős	October	2019.06.25	2020.02.20			Abortion day 240	twin	2019.07.15. one	2019.08.02. twin
Qmisz	Out Loud	2019.05.16-18	2020.04.11			euthanasia foal 2020.04.14.	weak		

Excel sheet 3. Breeding season of 2019



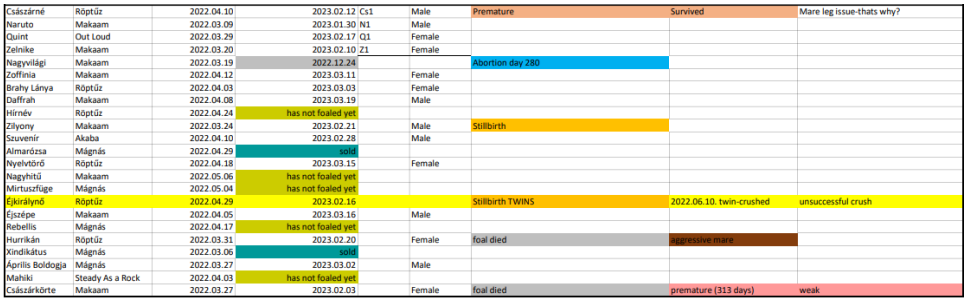
Xindi	Rolex Boy (e. Rojt)	2020.05.13-15	2021.04.10	Xirius	Male					
Wadkörte	Röptűz	2020.06.14-15	2021.05.21	Wadon	Female					
Szuvenír	Akaba	2020.05.22-29	2021.04.15	Szuvidáló	Male					
Szamóca	Steady As A Rock	2020.05.18-21	2021.05.04	Számtalan	Female					
Roxanne	Röptűz	2020.06.07-08	2021.05.21	Roxanelle	Female					
Naruto	Akaba	2020.03.13-18	2021.02.10	Narvik	Female					
Nagyvilági	Akaba	2020.03.12-18	2021.02.19	Nagyon Vadc	Female					
Nagyhitű	Akaba	2020.05.19-21	2021.04.22	Nagyharsány	Female					
Nádbuga	Röptűz	2020.02.29-03.11	2021.02.02	Nádi farkas	Male					
Mirtuszfüge	Röptűz	2020.03.05-08	2021.01.26	Mirtuszdió	Male					
Mondóka	Akaba	2020.05.19-21	2021.04.27	Makaba	Female					
High Rainbow	Steady As A Rock	2020.05.15-21	2021.04.07	High Speed	Male					
Éjkirálynő	Akaba	2020.05.08-09	2021.03.31	Éjfúria	Female					
Császárné	Akaba	2020.02.29-03.02.	2021.01.21	Csodabogár	Female					
Crimson	Akaba	2020.05.13-15	2021.04.14			2021.05.24. foal died		weak		
Criptonit	Rolex Boy	2020.05.22-29	2021.04.20			2021.05.20. foal died		purulent polyarthritis-bacterial infection		
No Art	Rolex Boy	2020.06.07-11	0			Abortion >110 days		2020.06.30 twin, right horn-crushed	2020.07.03. right horn crushed again	2020.07.15. pregnant 2020.09.28. pregnant
Dirty Dreamer	Röptűz	2020.05.18	2021.04.23		Dystocia	Foal died- stuck at birth canal		died some days later		

Excel sheet 4. Breeding season of 2020



Zoffínia	Atheneum	2021.03.01-09	2022.02.04	Zodiákus	Female	twin		2021.04.12. pregnant-one	foal: umbilical hernia+ accident (on pasture)	
Zilyony	Röptűz	2021.04.02-11	2022.03.14	Zilola	Male					
Zelnike	Esti Csillag	2021.03.09-11	2022.02.06	Zendülő	Male					
Xindi	Atheneum	2021.05.27.30	2022.04.27	Xintér	Female	rhodococcus equi foal		treated-survived		
Szonáta	Makaam	2021.05.27-30	2022.04.29	Szondi apród	Male					
Nyelvtörő	Mágnás	2021.05.10-13	2022.04.08	Nyelv Ész	Female			foal died-colic above 6months		
No Art	Akaba	2021.06.12-14	2022.05.10	No Limit	Female					
Naruto	Atheneum	2021.02.25-03.01	2022.02.01	Narcolepsia	Male					
Nagyvilági	Esti Csillag	2021.03.01-04	2022.02.03	Nagyvillám	Male	umbilical hernia		foal died-accident-above 6 months		
Nagyhitű	Röptűz	2021.05.19-24	2022.04.27	Nagyhirtelen	Male					
Nádbuga	Akaba	2021.03.13-24	2022.02.19	Nádirigó	Female					
Mondóka	Akaba	2021.06.21-25	2022.05.27	Mongyó	Male	1st cover: 2021.05.05-06		2021.05.24. twin	2021.05.31. right horn-crush	2021.06.07.other one i rebreeding
Mirtuszfüge	Atheneum	2021.06.01-06	2022.04.23	Mirabella	Female					
Hírnév	Mágnás	2021.03.26-04.01	2022.03.24	Hirth Alen	Male	2021.04.19. twin-same horn		2021.04.26. pregnant-one		
Dirty Dreamer	Mágnás	2021.06.01-03	2022.05.11	Diós Mákos	Male					
Daffrah	Akaba	2021.03.20-25	2022.03.04	Dafke	Male					
Császárné	Akaba	2021.04.01-06	2022.02.25	Császkálő	Male					
Criptonit	Out Loud	2021.06.16-23	2022.05.23	Critizáló	Female					
Brahy lánya	Atheneum	2021.03.05-11	2022.02.28	Brav Úr	Male					
Almarózsa	Akaba	2021.05.05-09	2022.04.01	A..	Female	rhodococcus equi foal		treated-died		
Blokád	Atheneum	2021.02.16	2022.02.16		Dystocia+Stillb irth	two FL+1 HL-repositioned, but the foal died during labour				

Excel sheet 5. Breeding season of 2021



Császárné	Röptűz	2022.04.10	2023.02.12	Cs1	Male	Premature	Survived	Mare leg issue-thats why?
Naruto	Makaam	2022.03.09	2023.01.30	N1	Male			
Quint	Out Loud	2022.03.29	2023.02.17	Q1	Female			
Zelnike	Makaam	2022.03.20	2023.02.10	Z1	Female			
Nagyvilági	Makaam	2022.03.19	2022.12.24			Abortion day 280		
Zoffínia	Makaam	2022.04.12	2023.03.11		Female			
Brahy Lánya	Röptűz	2022.04.03	2023.03.03		Female			
Daffrah	Makaam	2022.04.08	2023.03.19		Male			
Hírnév	Röptűz	2022.04.24	has not foaled yet					
Zilyony	Makaam	2022.03.24	2023.02.21		Male	Stillbirth		
Szuvenír	Akaba	2022.04.10	2023.02.28		Male			
Almarózsa	Mágnás	2022.04.29	sold					
Nyelvtörő	Röptűz	2022.04.18	2023.03.15		Female			
Nagyhitű	Makaam	2022.05.06	has not foaled yet					
Mirtuszfüge	Mágnás	2022.05.04	has not foaled yet					
Éjkirálynő	Röptűz	2022.04.29	2023.02.16			Stillbirth TWINS	2022.06.10. twin-crushed	unsuccessful crush
Éjszépe	Makaam	2022.04.05	2023.03.16		Male			
Rebellis	Mágnás	2022.04.17	has not foaled yet					
Hurrikán	Röptűz	2022.03.31	2023.02.20		Female	foal died	aggressive mare	
Xindikátus	Mágnás	2022.03.06	sold					
Április Boldogja	Mágnás	2022.03.27	2023.03.02		Male			
Mahiki	Steady As a Rock	2022.04.03	has not foaled yet					
Császárkörte	Makaam	2022.03.27	2023.02.03		Female	foal died	premature (313 days)	weak

Excel sheet 6. Breeding season of 2022

Mare	Stallion 1	Stallion 2	Covering	Info			
	2017						
Szantálfa	Atheneum		0				
Hildene	Esti Csillag	Satin Stone	0				
Gina Maxi	Makaam	Satin Stone	0				
Irish Edge	Makaam	Rendezvous	0				
Nemzeti összefogás	Makaam		0				
Queen's Night	Makaam		0				
The Moon and Back	Makaam		0				
High Rainbow	Rendezvous		0				
Irish Edge	Rendezvous	Makaam	0				
Naveen	Rendezvous		0				
Rózmarin	Rendezvous		0				
Serpa	Rendezvous		0				
Spinning Cystal	Rendezvous		0				
Vincencia	Rendezvous		0				
Criptonit	Satin Stone		0				
Gina Maxi	Satin Stone	Makaam	0				
Orange Lady	Satin Stone		0				
Poligráf	Satin Stone		0				
Szamóca	Satin Stone		2017.05.20-23	Aborbed before 07-14.			
Szibilla	Steady As A Rock		0				
Zara	Rendezvous		2017.06.20-21	Abortion/EED in between day 23-71	2017.07.14. pregnant	2017.09.02. Not pregnant!	
	2018						
sunny vale	category five		0				
szándék	category five	out loud	0				
vincencia	category five		2018.04.10-11.	2018.06.11. Absorbed < 60 days	2018.06.11. PG	2018.06.15. PG	
hildene	esti csillag		0				
naveen	esti csillag		0				
hírnév	makaam		0				
xindi	makaam	out loud	0				
celesta	out loud		0				
dynamite blond	out loud	Esti csillag	2018.06.10-11	absorbed <40 days	2018.06.10. pregnant-cyst	2018.07.23. absorbed	
samirza	out loud		0				
szándék	out loud	category five	0				
the moon and back	out loud		0				
xindi	out loud	makaam	0				
orange lady	rendezvous		0				
vadkörte	rendezvous		2018. 03.05-14	twin	2018.04.20. twin	termination-both in one horn-Prostaglandin	
no art	röptűz		0				
cristály	steady as a rock		0				
estemona	steady as a rock		0				
navigáló	steady as a rock		0				
nemzeti összefogés	steady as a rock		0				
poligráf	steady as a rock		0				

Excel sheet 7. Empty mares of 2017-2018

ESTEMONA				accident-mare died	2018.11.05	ilium-comminuted fracture-internal side	accident on pasture
	2019						
Almaszirom	Atheneum		0				
Crimson	Makaam		0				
Hírnév	Makaam	October	0				
Miss Annie Joice	Makaam	Out Loud	0				
Poszáta	Makaam		0				
Zara	Makaam		0				
Panama	Mediplomat	October	0				
Sharon's Stone	October		0				
Szatíra	October		0				
The moon and back	October		0				
Valeriana	October		0				
Miss Annie Joice	out loud		0				
Qltúra	Röptűz		0				
Should I Stay	Steady as a rock		0				
Szonáta	Stready as a rock		2019. 06.11-13	absorbed before day 40	2019.06.30. pregnar	2019. 07.24. absorbed	
Hildene	October		2019.04.24-25	2019.05.13. twin	close to crush	2019.05.30. too close to c	termination-PG
Sunny Vale				2019.03.27	mare died-colic		
	2020						
April's Music	Akaba		0				
Sármány	Akaba	Röptűz	0				
Szonáta	Akaba		0				
Zara	Akaba		0				
Nemes	Rolex Boy		0				
Vincencia	Rolex Boy		2020.06.10-11	Absorbed before day 40	2020.06.30. pregnar	2020.07.14. absorbed	
Brahy Lánya	Röptűz		0				
Zelnike	Röptűz		0				
Rózmarin	Steady as a rock		0				
	2021						
Almarózsa	Akaba		0				
Szuvenír	Atheneum		0				
High Rainbow	Mágnás		0				
Queen's Dancer	Mágnás	Röptűz	0				
Szamóca	Mágnás		2021.05.16-17	day70	2021.07.05. vemhes	2021.07.27. absorbed	
Éjkirálynő	Röptűz		0				
Crimson				mare died-colic	2021.05.23		
	2022						
Nádbuga	Makaam		2022.05.04	foal on foot	sold-empty	2022.05.20. pregnant	2022.06.10. absorbed
Xindi			0	foal on foot			
No Art			0	foal on foot			
Criptonit			0	foal on foot			
Mondóka			0	foal on foot			
Dirty Dreamer			0	foal on foot			
Szonáta			0	foal on foot			
Blokád			0	no foal on foot			

Excel sheet 8. Empty mares of 2019-2022

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University of Veterinary Medicine Budapest

Department of Obstetrics and Food Animal Medicine Clinic

I hereby confirm that I am familiar with the content of the thesis entitled *„Control of equine parturition in a Hungarian Thoroughbred farm"* written by **Katalin Réka Dinga** (student name) which I deem suitable for submission and defence.

Date: Budapest, 24 day March month 2023 year

Dr. Ottó Szenci

.....

Supervisor name and signature

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Thesis progress report for veterinary students

Name of student: Katalin Réka DINGA

Neptun code of the student: ICEY32

Name and title of the supervisor: Prof. Dr. Ottó Szenci

Department: Department of Obstetrics and Food Animal Medicine Clinic

Thesis title: ***Control of equine parturition in a Hungarian Thoroughbred farm***

Consultation – 1st semester

	Timing			Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2021	04 05	30 19	Szakdolgozati téma kiválasztása	Dr. Ottó Szenci
2.	2021	08	23	Szakdolgozathoz szükséges adatok gyüjtése	Dr. Ottó Szenci
3.	2021	09	09	Adatok gyűjtésével és feldolgozásával kapcsolatos konzultáció	Dr. Ottó Szenci
4.					
5.					

Grade achieved at the end of the first semester: jeles (5)

Consultation – 2nd semester

	Timing			Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2022	12	15	Szakdolgozat elkészítése	Dr. Ottó Szenci
2.	2022	12	27-29	Szakdolgozat elkészítése	Dr. Ottó Szenci
3.	20223	03	01-24	Szakdolgozat elkészítése	Dr. Ottó Szenci

Grade achieved at the end of the second semester: jeles (5)

The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and found suitable to defence,

Dr. Ottó Szenci

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Signature of the secretary of the department: .....

Date of handing the thesis in 27 MARCH 2023