1. THE PREMISES AND THE AIMS OF THE STUDY

The economic background of the breeders of the traditional breeds is very hard in Hungary of the 21st century. Our breeds must meet the challenge on a unifying market of world breeds that posses a base having been selected for sport, organized professional background and support, better infrastructure and significantly better financial finance. Nevertheless we must take this concurring fight for making our heritage breeds survive. We must find opportunities for emerging our historic horse breeds and their breeders to better positions supported by a well-based professional approach. One of these opportunities would be the creation of a process that assists our selection decisions in the early stages of the 1-year-old individuals, saving us the considerable costs of the raising and confronting the system in practice. Decreasing the interval of the selection period is not a new idea in horse breeding. It is demanded by the professional and economic approach because of the time and money invested in breeding a successful athletic sport horse.

When examining the systems of selection I found that in the sport selection the most efficient way is gaining a authentic picture of the horse' motion skills. Many professional publications praise the advantages of using the free jump regularly (A.Palman 1968). It is first mentioned by Ócsag (1968) as a base for a selection used in horse breeding. Later Bekadam-Koops (1976) of the Netherlands and Bruns and Bade (1979) from Germany suggests that free jump should be considered as a base for selection and rejecting the artificial testing conditions we must concentrate the motion skills of the horse surfacing in this action. Bekedam-Koops warmed us in 1979 that a jumping horse should be valuated by the performance in free jumping. Hellsten claims in a study (2005) that one will find the closest correlation between the

jumping performance on various stallion tests and the performance in future jumping competitions. This study names the performance tests in the early age as a more effective tool to create an objective report on the skills of the individuals than the future results in different competitions. Brockmann (1998) has the result of r=0.95 as the correlation between the performance in free jumping and the performance in a show jump routine. Ducro (2006) has the average of r=0.80 when calculating the results of a free jump test by Dutch sport stallions and their later show jumping performances. Considering these findings we face the question of creating a system that could provide objective data from the individuals early age for helping our selection decisions.

The countries leading in horse breeding are more purposeful with using the systems of movement quality test in the mount horse qualifications. Using some kind of a picture recording technique is more frequent when evaluating the performance in a free jumping test although it is less usual with rating the basic stride methods.

There is not a consensus for the specifications for a successful jumping horse''s characteristics or the discovering these characteristics in the early age of the individuals. Anyhow, there seems to be an agreement about a huge correlation between the chronological order of limb placement during the jump and their role in supporting when examining colts and adult horses (Santamaria et al. 2005). The 1-year-old horses qualified for promising jumping talents showed advantageous jumping techniques at the age of 4, too. Bobbert (2005) names some characteristics in the jumping techniques of the colts that can be the basics for forecasting the individuals' future jumping skills. These are the position of the front and rear legs after the jump off and before landing. A colt with promising skills has a front leg more flexed at the carpus and elbow than its weaker performing mates. The same colts do not

close or bend their rear legs over the obstacles. The individuals' style and skills for jumping are determined by the differences of the leaping intensity of the front and rear limbs influencing the trajectory of the center of gravity. (Barrey et al. 1977). The trajectory of the centre of gravity is flatter over the obstacle with the weaker jumpers (Cassiat et al. 2004). This observation may come from the leaping intensity of the limbs.

Van den Bogert (1994) analyzed the kinetics of elite jumping horses and found that the leaping intensity of the rear limbs was the factor that determines the most a horse' jumping performance. Galloux (1997) says that one may observe the correctional movements of the body parts in the levitation phase of the jump, after the leap, influencing the rotation's pickup of angle. During levitation every bodypart supports the flattest possible trajectory of the centre of gravity and the preparation of the body for a landing without a fraction of the body's rotation. The rotation is mostly influenced by the head, the neck, the torso and the rear limbs. The correctional positions of these body parts in the levitation phase may characterize the individual.

According to the measures done by Galloux (2006) one may assume that the origin of the style and skill differences of the individuals would be the different leaping intensity of the front and rear limbs.

When starting the study our goal was to create a professional, objective pre-selection method that can help in the up-to-date selection of the colts at the age of one keeping the rules of gene preservation. For the objective and professional selection we aimed at a data collecting that could be arranged without the involvement of a rider. Since Gidran filed the most success in sports that are based on the jumping skills we started to create a system that selects the individuals by this skill.

For an accurate and sport-oriented estimation of the value of the measurable characteristics in the study we used the correlation and solidity of the data recorded during performing jumps at the age of 1 and 3.

We aimed at finding the answers for these questions:

- Beside the historic and cultural heritage is there a practical value in the Gidran breed that would promise successful performances in the international horse sports;
- Is it possible to create and work a system that would help in the accurate selection of the talented individuals at the early age providing economic and professional background for preserving the breed's former skills
- Can we define characteristics, parameters that can differentiate the optimal and less optimal range of movements;
- Can the range of movements characterize the individual at various its stages of life
- Is there a correlation between the colt's results recorded at the age of 1 and 3. The claimed to be too early pre-selection, at the age of 1, can be professionally acceptable.

The final goal of this thesis and our breeding efforts is proving the original value of the Gidran breed and thus improving the international market share.

2. MATERIALS AND METHODS

We randomly select 12 colts of the Gidran breed and from the same stud farm and we have the same motion analyses at the age of 1 and 3 years.
The colts were observed individually in a 22x42 m hall with a 12 meter long observing corridor along the longer side but without lateral walls. In the observing corridor we arranged an oxer jump. The advantage of this setup is that it makes us to be able to observe and record the motion of the colts without any obstacle or disturbing element in sight and use the helping whip in the most optimal position when needed. The colts stayed in the corridor without having a rider correcting (i.e. distorting) their movements so the performance was characteristic for the individual. Due to the special measurement setups we tested the colts only with an oxer jump without a going in cross in order to observe constant style elements in spite of the different jumping situations. We helped the colts only with gaining right rhythm and speed but nothing else. In spite of the unusual circumstances having passed a standard training the colts easily performed oxer jumps at maximum 1.1 m at the age of 1 and maximum 1.6 m at the age of 3. In the first phase of the measurement we selected 5 pictures for analyses taken of jumps over an obstacle of 0.8-1.0 meter high by both groups of colts of the age of 1. In the second phase of measurement we selected 10 pictures for analyses taken of jumps over an obstacle of 1.2-1.3 meter high.

In line with the first element of the oxer jump we set up a digital camrecorder (JVC HD-10) and recorded the actions with the shutter speed of 29 picture per second. For analyzing the pictures we used the in-house developed software ‘Szelektor HDPG 02’.

We have taken approximately 20 pictures of each colt jumping in both phases. We have selected 4 pictures the most characteristic for the individual out of these jumps as to preparing the analyses of all-together 96 jumps by the 12 colts.

The colts in the study were divided into two groups: the group of more and less mistakes. The basis of this categorization was the daily jumping report made on the training and recording days of the colts in the second measurement phase, so at the age of 3. We made a note of the successful and missed jumps. We marked a jump for a miss jump if the shape of the obstacle changed after the jump. Foals were called ‘definitely talented’ if they made the less mistake, the most flawless jumps in the second measurement cycle. Foals were called ‘less talented’ or ‘badly jumping’ if most mistakes and less flawless jumps were made. Using this method we separated the 12 colts into 2 groups. 6 colts made into the group of good jumpers and 6 colts were selected for the group of bad jumpers.

During the training the colts could approach the test obstacles by trotting or galloping, although the jumps for analyses were started from galloping. We painted marker-points on the definite bodyparts of the colts.

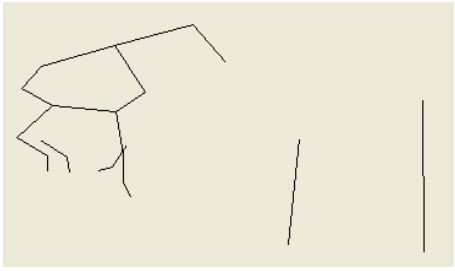
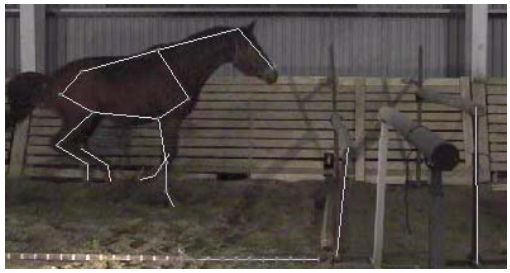
When doing the analyses we always considered the jump off moment of the supporting front leg as the reference point. We divided the jump, as a set of movements, into two phases. Phase I starts when the front single leg finishes the last gallop jump by touching the ground. Phase I ends with the moment of the rear pair of legs leaping from the ground (pictures 1-4). Phase II starts with this moment and finishes by touching the ground (pictures 5-6). Both phases consist of important elements (**see the set of pictures**).

Phase I: consists of the elements that lead to the active set of the trajectory (preparation of the jump by changing the order of legs between the last galloping step and the leap).

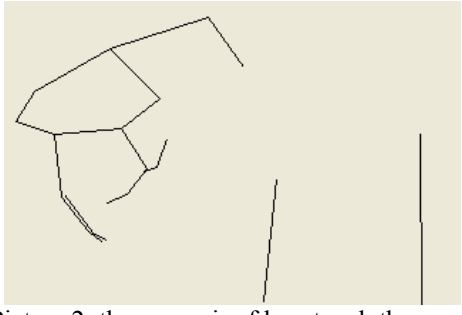
Phase II: passive levitation (the correctional movements tailored to the trajectory between the leap and landing)

The set of pictures of the phases and subphases of the jump:

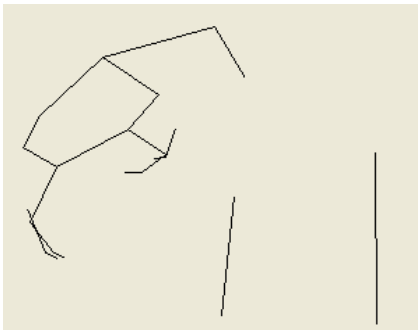
Phase I

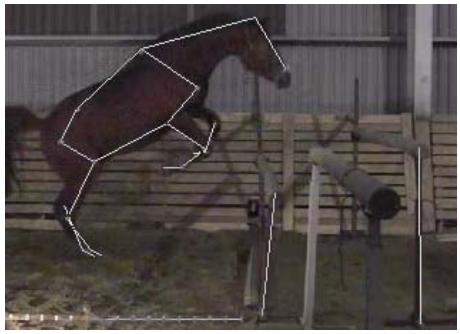



Picture 1: the front leg is commencing the lift of the torso.



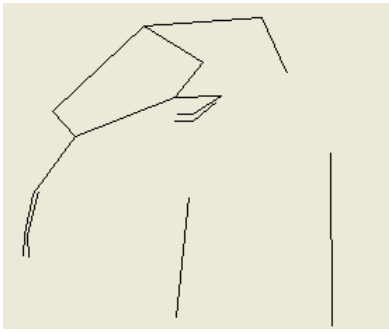

Picture 2: the rear pair of legs touch the ground.



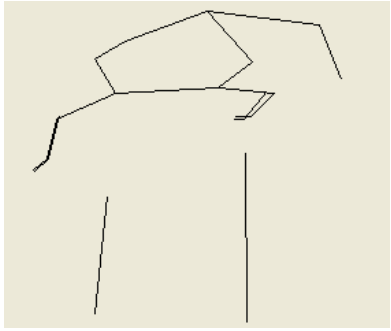


Picture 3: the rear pair of legs finishes the flexing subphase, the start of the pushing subphase.

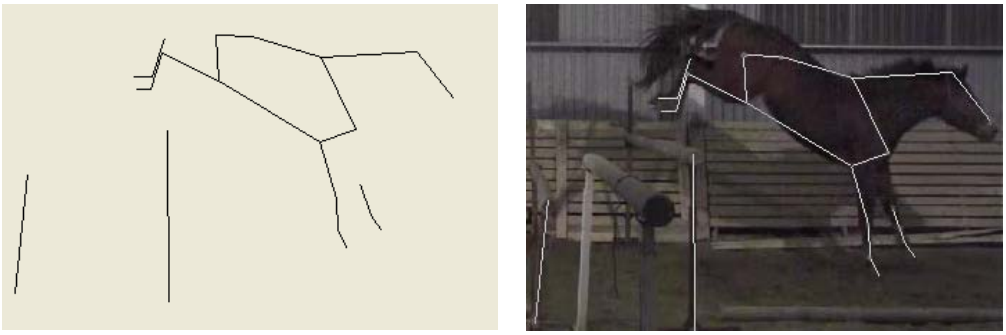
Phase II



Picture 4: end of leaping and start of levitation.

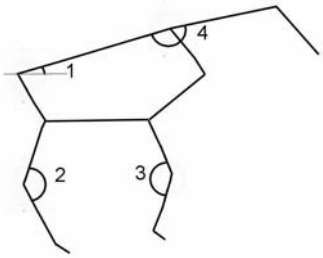


Picture 5: levitation at the top of the trajectory.



Picture 6: landing, the front leg touches the ground

We divided the movements into smaller elements and using the marker-points we associated co-ordinates and values to the key-movements in order to make graphic and mathematical analyses accessible. We measured the change of angles determined by the knee-**hock**-fetlock, elbow-**carpus**-fetlock; outer tuber coxae-**withers**-occiptus as well as the angle of the outer tuber coxae-withers and the horizont in both phases of the jumps.



We determined the characteristics of the jumping style for each individuals. Also, we compared those findings at the age of 1 and 3.

These are:

1. Lifting the torso (i.e. centre of gravity) from the leap of the front legs to the landing of the rear legs, the start of the pushing subphase (Phase I).
2. The flexing of the rear legs at the stifle-hock-fetlock from the leap, or mainly from the top of the trajectory to the landing of the front legs (Phase II).
3. The flexing of the front legs at the elbow-carpus-fetlock from leaping to the top of the trajectory (Phase II).
4. The bascule from leaping to the top of the trajectory (Phase II).

When evaluating the graphics we must know the frames of the recorded picture that are subphases of the jump. Also we must know the point where we measured and compared the above mentioned 4 characteristics (see the set of pictures).

These always are:

- The support of the front leg before the leap
- The rear legs landing at the same time before the leap; this is the start of the flexing phase at the same time
- The start of the pushing subphase of the rear legs (the end of the flexing subphase)
- The end of the pushing subphase of the rear legs, leaping (this is also the start of the levitation and Phase II)
- Levitation at the top of the trajectory
- The front legs touching the ground, start of landing

For the statistical analyses of the results we used the SAS (2001) GLM (General Linear Model) process for the variety analyses. The height of the obstacles was evaluated within the age groups since it was different for both. The model also considered the random effect of the quality of the jumps (weak or good) within the age group as well. The structure of the model was:

$$Y_{ijk} = \mu + A_i + B_j(A_i) + O_k(A_j) + e_{ijk}$$

meaning:

Y_{ijk} = angle variate;

A_i = the constant factor of the age (1, 3 years old);

Bj= the random effect of the quality of the jump within the age group;

O_k = the constant factor of the height of the obstacle within the age group (0.9, 1.0 and 1.1 m at the age of 1, and 1.1, 1.2, 1.3 at the age of 3)

e_{ijk} = the random residual term.

We estimated our variate components for age (kor) , individual (ló) and individual/age correlation by the SAS VARCOMP process (2001). Összes means 'total'. The repeatability and the reproducibility were estimated as suggested by Jansen and colleagues (1985):

repatability (r_1) $= \left(\sigma^2_{\text{LÓ}} + \sigma^2_{\text{KOR*LÓ}}\right) / \sigma^2_{\text{ÖSSZES}}$

repoducibility (r_2) $= \sigma^2_{\text{LÓ}} / \sigma^2_{\text{ÖSSZES}}$

meaning: $\sigma^2_{\text{LÓ}}$ = variate of the individuals;

$\sigma^2_{\text{LÓ*KOR}}$ = variance component of individual x age;

$\sigma^2_{\text{ÖSSZES}} = \sigma^2_{\text{LÓ}} + \sigma^2_{\text{LÓ*KOR}} + \sigma^2_{\text{HIBA}}$, where σ^2_{HIBA} : error variance.

3. RESULTS

The result of the study is a sum of the development of the technical elements in the selection methodology and the analyses of the jumps by the foals of 1 and 3 years old including the correlation between them.

The system developed during the thesis activities was created with the intention of its practical use in mind. Using this system must help the selection of better perfoming jump horses. One of the most important technical elements of the system is the use of the oxer jump without a going in cross that makes the evaluation of the colt's jumping skills and abilities easier even in changing jumping circumstances. Due to the more difficult conditions the colt's ability to map and correct is easier to comprehend.

Our study shows that there are 4 characteristics that determine the jumping style of the individual. These are:

1. Lifting the **torso** (i.e. centre of gravity) from the leap of the front legs to the landing of the rear legs, the start of the pushing subphase (Phase I).
2. The flexing of the rear legs at the stifle-**hock**-fetlock from the leap, or mainly from the top of the trajectory to the landing of the front legs (Phase II).
3. The flexing of the front legs at the elbow-**carpus**-fetlock from the top of the trajectory to the start of landing (Phase II).
4. The **bascule** from leaping to the top of the trajectory (Phase II).

Using these characteristics responsible for the jumping style, we were looking for jumping characters that do not change by the age and are easy to repeat between the individuals' age of 1 and 3, as a considerable constant

values. In both cases the better repeatability within the age group was important, too.

For the preselection the bascule is the most important factor in the interval from the start of Phase II (the leap) to the top of the trajectory. We may claim that there is no difference between the bascule as the expression of a jumping style characteristic of good jumping and bad jumping individuals. The expression of this characteristic is the strongest at the moment of the leap in each case. Nevertheless we detected a significant difference in holding the bascule by the individuals of the better and worse jumping groups. In both age groups there is a significant difference with this characteristic at the top of the trajectory since the better jumping individuals show a smaller variate of angle for tuber coxae-withers-occipital between the leap and the top of the trajectory than the worse jumpers. The expression of the of the bascule with the better jumping individuals at the leap is 210,8˚ ± 2,23˚ / 210,0˚ ± 2,27˚. These values at the top of the trajectory are modified to 206,7˚ ± 2,60˚ / 209,3˚ ± 2,35˚. The expression of the of the bascule with the better jumping individuals at the age of 1 or 3 at the leap is 211,1˚ ± 2,16˚ / 206,7˚ ± 2,24˚. They show modified values of 198,1˚ ± 2,51˚ / 203,2˚ ± 2,3˚- at the top of the trajectory. This also means that the better jumping individuals' bascule is better held than the worse jumpers'.

Our calculations show that the grade of flexing the carpus during the jump is not referring to the jumping ability of the colts but remains a characterizing factor for each individual. The repeatability of it is good or average from the pushing subphase of Phase I (0.21-0.46) which makes it an important character of the jump. Also, our measurements show that during the jump the most flexed position of the carpus is at the moment of the leap. We detected a difference of the grade of flexion of the capus at the different ages. The

carpus of colts of 1-year-old is less flexed when jumping than that of the colts of 3-year-old. At the leap the flexion of the caprus is 66.1˚ within the well jumping group of 1-year-olds and 53.5˚ within the well jumping group of 3-year-olds. The weak jumpers' show this characteristic at 64.5˚ at the age of 1 and 53.8˚ at the age of 3. Comparing the grade of flexing the carpus carpus of the better and worse jumping groups we cannot outline a tendency of better jumping horses performing jumps with better closed and uplifted front legs. None of the age groups shows correlation between the jumping ability and the flexion of the carpus . So we exclude this characteristic from the early selection.

We defined the change of angle of the torso lifting by the change of the angle between the horizon and the tuber coxae-withers. This characteristic responsible for the jumping style shows the pushing intensity of the supporting front leg from Phase I of the jump to the end of the pushing subphase of Phase I. We cannot associate any ability to lift the centre of gravity to the pushing front legs since the jumping horse in Phase I makes an effort to have least possible lift of centre of gravity by moving its significantly heavy head an neck forward and upward. The goal of this interval is to reach an ideal position that is required between the centre of gravity and the supporting, pushing rear legs for the optimal trajectory. Our study shows that in Phase I of the jump the better jumping colts of both age groups perform a bigger change of angle with their torso than the worse jumping mates thanks to the pushing intensity of the supporting front leg. These results teach us two things. The better jumping colts of both age groups show a bigger angle of the withers-tuber coxae and the horizon during every moment of the jump than the worse jumping horses. On the other hand the colts show a bigger torso-tilting angle at the age of 1 than the

age of 3, no regards to their ability group. The repeatability of the data is the average or good from starting the pushing subphase of Phase I (0.27-0.57, and 0.27-0.48). Though we could not detect any significant difference between the two groups of any age or jumping phase, we still believe that this is one of the most important characteristic that expresses the jumping ability of the colts.

We drew a conclusion about the pushing intensity of the pair of the rear legs from the changes of the flexion of stifle-hock-fetlock during the jumps. This changes of angle prepare the jump in Phase I, and in Phase II help the horse body to reach the optimal trajectory during levitation with the balancing activity of the rear legs. In the moment of the front legs being supported we measured significant differences in the flexion of the hock at both age groups. At the age of 1 the two groups have the smallest quadratic average at 102.5˚ ± 3.59 and 116.7˚ ± 3.49˚. The colts of 3 produced a result of 97.5˚ ± 3.05˚ and 105.5˚ ± 2.99˚ with the better jumping and worse jumping groups. The individuals in the better jumping group performed the subphases and measurement points of Phase I with a more flexed and more active hock. In Phase II at the top pof the trajectory this difference disappears between the two groups and our study shows that the better jumping groups' individuals have a smaller change of angle at the hock till the landing of the front legs than the same factor with the worse jumping group. At the age of 1 the quadratic average of the change of angle at the hock between the top of the trajectory and landing of the front legs was 40.7˚ with the good performing colts and 43.6˚ with the badly performing horses. The same change at the age of 3 was 30.4˚ and 44.8˚. At the age of 1 it is not significant but at the age of 3 it is obvious that there is a difference in the range of flexing the (it is 91,7˚ ± 4,79˚ with the good jumpers and 69,6˚ ± 4,75˚ with the worse

jumpers.) According to these findings we may say that the change of angle at the flexion of the hock between the top of the trajectory and the landing of the front legs defines the intensity of leaping, thus the ability to jump of the colts. This tendency grows stronger as the individual grows older.

4. CONCLUSIONS

The oxer jump without a going in cross used in the free jump is able to show the objective differences between the jumping style and ability of the colts after training.

Considered as a set of movements and divided into phases the jump helps the evaluation of the jump style and the ability to jump.

3 out of the 4 characteristics forming the jump style help us in drawing conclusions about the jumping abilities of the individual. These are:

1. The change of bascule from leaping to the top of trajectory.
2. The lifting of the torso from pushing the front legs to the landing of the rear legs and the start of the pushing subphase based on the angle between the horizon and the outer tuber coxae-withers.
3. The flexion of stifle-hock-fetlock of the rear legs from the top of the trajectory to the landing of the front legs.

The flexion of the elbow-carpus-fetlock of the front leg as a characteristic of the jumping style is not defining the ability to jump of the individual.

The characters of the jumping style may change with the age. For the selection decisions it is important to be aware with these:

1. The differences in holding the bascule between the leap and the top of trajectory refer to the difference in abilities between the individuals already at the age of 1. The better jumping foals' bascule is better held than that of the worse jumpers.
2. The flexion of the capurs of the colts of 1-year-old in the study was more open and less flexed at any subphase of the jump. This finding is not to help our selection decisions.

3. The individuals with better jumping abilities show a bigger angle between the horizon and the torso-tilting originating from the pushing intensity of the front legs than the individuals with worse results.
4. The foals with better jumping results have a smaller change of angle at the hock between the top of trajectory and the landing of the front legs than the individuals with worse results. The character changes significantly with the age but the tendency can be detected at the age of 1 with the help of the movement analyzing tools..

5. NEW RESEARCH RESULTS

1. A movement analysis method were developed (with the special infrastructural elements and measuring settings) which is suitable for the early (around age of 1) estimation of the jumping ability of the colts.
2. The jump as a range of movements can be divided into two phases and 3-3 different subphases in each phase. Phase I contains of the elements that prepare the leap by changing the order of legs between the last gallop / trot step and the leap. Phase II shows the correctional movements tailored to the levitating trajectory between the leap and landing.
3. Every individuals' style of jumping is created by 4 style elements. In the phases of the jump these are: the flexion of the carpus; the change of the angle defined by the horizon and tuber coxae-withers (torso-tilting); the change of the flexion of the hock; the change of the expression of the bascule. These four elements of style defined the style of jumping of the individual, though only 3 of the 4 can forecast the jumping skills of the individual.
4. In the phases of jump the flexion of the caprus has no effect on the jumping skills of the individual.
5. In the second phase of the jump from the top of the trajectory there is a difference of the change of the angle at the hock between the good and bad jumping individuals. In this interval the amount of the close of the hock is smaller at the better jumping horses with no regards to the age. The better jumping individuals land with a more open angle

of the hock than the worse jumpers. This characteristic difference is growing by the age.

6. During the jump there is no significant difference of the measure and expression of the bascule between the good and bad jumping individuals. This style element is most expressed at the start of Phase II, in the moment of the leap. Anyhow, there is a difference in holding the bascule until the top of the trajectory between the good and bad jumping horses no regards to the age.

6. PUBLICATION LIST

Publications written in Hungarian:

MIHÓK S.-**JÓNÁS S.** (2005): A sportló szelekciója (a tenyészértékbecslés lehetőségei) Állattenyésztés és Takarmányozás, Herceghalom. 54. 2. 121-132

JÓNÁS S. – MIHÓK S. (2006): Objektív mozgáselemzés módszerének kidolgozása a tradicionális gidrán lófajta sportirányú szelekciója érdekében. In: Génmegőrzés (Hagyományos háziállatfajták genetikai és gazdasági értékének tudományos feltárása). 172-199

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Publications written in foreign language:

JÓNÁS, S. – KOMLÓSI, I. – POSTA, J. – MIHÓK, S. (2008): The jumping capacity of young horses predicted by stifle-hock-fetlock angulation in free-jumping. Állattenyésztés és Takarmányozás, Herceghalom. Megjelenés alatt

Reviewed scientific conference:

Jónás S. (2006): Csikók sportirányú szelekciójának lehetősége. Debrecen