ABSTRACT

RESEARCHES REGARDING OSTRICH REPRODUCTIVE PARTICULARITIES

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The goals of the current thesis are information acquiring, ordering and presenting it in a visual representation, diagnosis and in-depth knowledge of the pathological processes, and also of the elements that can influence the incubation, hatching, and breeding of the ostrich chicks. The theme intends to review some illnesses' clinical diagnosis criteria and also to focus on relations between the frequency of the ilnesses and the ostrich female's age, bodily structure, egg production, the season of the year, and several factors that influence the bird's health status. The statistical methodology takes into account the direct observation and data recording during the various stages of the breeding process, the processing of the gathered data and recording it in a visual form, as well as the analysis of the info assets and tracing of several elements that can negatively influence the ostrich breeding.

First Part – **Stage of knowledge** consists of 4 chapters and 62 pages (32,80 %) that contain selected information from 116 Romanian and foreign bibliographical sources regarding the male and female genital aparatus's morphostructure and physiology on birds in general as well as ostriches in particular, data regarding incubation and hatching, plus the most important illnesses that can influence the ostrich breeding.

Second Part – **Own research** – consists of 9 chapters and 127 pages (67,20 %), contains the purpose and goals, material and work methods, gathered results and their interpretation, and finally the conclusions. The study material consisted of 8 ostrich families composed of 24 individuals: 8 males and 16 females, which were observed during a period of 7 years. The clinical investigation methods of the breeding period were: anamnesis, abdominal palpation, cloacal examination, anatomico-pathological examination, as well as hormonal dosage. The clinical examination is an investigation method used to gather data which is very useful in making a correct diagnosis. Such data is gathered through a general clinical

examination, through inspection, abdominal palpation, cloacal touching, copulating tube examination, as well as the ovoscopic examination of the eggs batch. The introductory part focuses on the geophysical study of the area and the study of the natural conditions that belong to the area, emphasising on the knowledge of the climatic factors (temperature, precipitation and wind conditions), location of the farm according to the area's relief and socio-economic conditions.

Transportation and populating the farm – between June 15th – July 15th 2001, the SC Petlux SRL Nartesti Company from Gohor has imported 24 AFRICAN BLACK, 3-year old ostriches, according to the origin certificates; the birds were separated into 8 breeding families.

Shelter arrangement and accomodation – the most important factor in ostrich breeding is the large area that needs to be allocated to each ostrich, which has to be large enough so that the bird doesn't feel constrained. Therefore, each ostrich needs 25m^2, while the breeding ostrich needs an area of 200m^2 or 500m^2 per family, plus other various facilities (food and drinking places, areas for eggs-laying and shed). The area of the paddocks is rectangular, separated by 2.5m high wire mesh which needs to be 0.5m deep buried in the ground.

The shelter has to be placed at the end of the paddock in order to protect the birds from sun heat or bad weather. The staff will access the paddock area through a door on the back side of the shelter. The food and watering locations need to be placed to the other end of the paddock, 40 – 50cm up from the ground, and have to be made of materials that are easily washable.

Formating of breeding flocks – the birds selection was needed in order to choose the individuals and formating of the breeding families based on morphologic criteria, because the individual capabilities of each bird were unknown. Therefore, the males were selected considering their: age, weight, body massiveness, back length and lack of humpback, legs massiveness and length, attitude and behaviour, agressivity and vigilance. The female ostriches were selected considering some of their morphological aspects, such as: health condition and proper outer attributes, gentle temperament, etc. There were formated 8 families (8 males and 16 females) which were accomodated into a dedicated area that was individually separated on 500m^2 for each family and a shelter area of 30m^2 placed on one of the ends of the paddock.

Breeding and egg laying season – in Europe, the ostrich season of laying eggs lasts 8 – 9 months (March - September). For the purpose of the beginning of the egg laying season, the birds will be fed with fodder rich in protein, vitamins and minerals starting January – February. The birds will then begin to change their aspect and behaviour: the males' beak and tarsus become reddish, while the females begin to move their wings and their beak (nuptial dance). The copulation lasts 1 -3 minutes, then the birds leave together. 2 – 4 weeks later, the females start laying eggs.

The influence of feeding on breeding – Considering the fact that many breeding parameters are directly influenced by nutrition, the ostrich feeding during the breeding period will use concentrated fodder based on green alfalfa or alfalfa hay, PVM concentrate and grains. The ostrich diet will be differentiated according to their activity:

- during the resting period, the feeding will be made only to ensure the maintenance requirements of the ostriches, therefore the fodder will contain a high cellulose ratio and a moderate percentage of raw proteine and energy
- 30 – 40 days before the beginning of the breeding season, the fodder will be energy-protein and vitamin-mineral improved

The possibility to prevent and control the ostrich sterility – in order to have a high breeding rate, the ostriches need to be fed and cared rationally, starting with the growing period and ending with the period of reconditioning for revaluation and consumption. A faulty and vitaminic-mineral unbalanced feeding will cause the inhibition of the pituitary hormon secretion and therefore decreasing of the ostrich breeding capabilities: lack of libido, ovary preparation deficiencies, inconsistency between male and female libido etc. There has to be taken into consideration that the ostrich male sexual maturity occurs after 4 years of age, the female reaches sexual maturity at the age of 2.5, but the sexual cycle begins much later.

The ostrich eggs' incubation – it's the process of controlling several physical environmental factors in order to obtain a healthy and viable youngster from a normally-built bird egg. The mature, fertilized ovule will cross the oviduct, where it will be wrapped into the 2 whites layers, 2 shell membranes, and then the eggshell during the 46 – 50 hours until it will be expelled through the cloaca, a process known as **ponta**. All these maturation and egg formation stages can be negatively affected by certain stress-caused conditions of the ostrich female, fact that lowers the quality of the egg for incubation.

Contributions to the knowledge of the quality of the ostrich destined for incubation

Quality markers of the incubation eggs – If the eggs for incubation originate from healthy birds, which possess a good genetic potential and have been raised under good food and microclimate conditions, the eggs' quality will be high, fact which will result in very good markers during the incubation process. The egg-production sheet of the ostrich female will always be used to record every event of egg harvesting, mentioning the female identification number, the paddock or housing cell and also the egg date and time. The eggs which are good for incubation have a clean, smooth and unbroken shell, with the air chamber placed to the rounded end of the egg. The weight of the eggs vary between 1100 – 2300 g, the average weight ranging from 1450 to 1850 g. The eggs that weigh more than 2300 g but also the ones below 1200 g will not be used for incubation. The quality of the eggs for incubation is influenced by their:

freshness, morphological markers (shell faults, double yolk etc), weight, shape, volume, specific weight, and also the shell mottling degree.

The artificial incubation of the ostrich eggs – the normal development of the embryo can only occur under certain conditions of temperature, humidity, gases exchange, egg position and rotation which are achieved with specialized devices into the **thermostatic capsule**. The egg incubation is run at a temperature between 36.2ºC – 36.6ºC and a relative humidity of 38 – 43%. The air inside the incubator is composed of 21% O_2 and 0.03 – 0.04% CO_2, while the air speed is kept between 0.1 – 1.8 m/s.

The particularities of ostrich eggs' incubation – the ostrich eggs are harvested once a day and will be deposited for 7 days on shelves into a special room where the temperature is kept between 15 – 17ºC, then they will be inserted into an incubation facility. The eggs need to be disinfected immediately after harvesting with a special device, by using 80g potassium permanganate, 130ml formalin 40% diluted and 1ml iodine tincture for each $3m^3$ air. Washing of the eggs destined for incubation is strictly forbidden. Prior to inserting the eggs into the incubation facility they need to be examined with an ovoscope in order to visualize the integrity of the chalazes, the position of the yolk and of the air chamber (which will be marked on the egg shell with a pencil). The embryo development control should be made on the 14^{th} – 28^{th} – 39^{th} days of incubation, and the eggs' transfer into the hatching unit will be made 3 days before the hatching.

The hatching – the temperature into the hatching unit will be decreased by 0.6ºC (35.5ºC) and the humidity will be increased by 8%, the egg rotation will be ceased, and the position of the egg will be set so that its air chamber is facing upwards. The hatched chicks need to have their chord button buffered with 7% diluted iodine tincture, and the hatching leftovers will be removes in order to prevent chick injuries.

The analysis of the incubation process of the studied ostrich eggs – the thesis outlines the dynamics of the egg production, the incubation and hatching in an ostrich breeding farm, and also an outlook of the improvement of these markers, by taking into account several factors that can influence the breeding indicators. The research that were done over a period of 7 years on the 8 ostrich families took into account comparative studies of several incubation parameters, such as: the total amount of eggs, faulty eggs, eggs used for incubation, eggs removed on the 1^{st} and 2^{nd} ovoscopic examination, eggs with dead embryos, as well as the amount of hatched chicks. Therefore, during the 7 years of study, the 8 ostrich families have produced 2544 eggs, only 1346 (53%) of them have been used for incubation. Out of the 1346 eggs used for incubation, 532 eggs (40%), have been removed after the 1^{st} and the 2^{nd} ovoscopic examination, and 217 eggs (16%) contained dead embryos and other 75 (3%) were faulty. Once the incubation

process was complete, only 597 healthy and viable chicks (44%) have hatched successfully. Based on a precise analysis of the incubation and hatching process, we notice that the incubation percentage was 58% and the hatching percentage was 44 % during the 7 years of study. The best results were obtained in 2002 when out of 196 eggs, 147 of them were used for incubation (75% incubation percentage), resulting in 88 hatched, viable chicks, therefore a hatching percentage of 60%.

The amount and percentage of infertile eggs – the highlighting of the possible physicochemical and anatomo-pathological changes during the embryo development process is done through ovoscopic examination on the 14^{th} – 28^{th} – 29^{th} day of incubation. If after 28 incubation days there are no modifications related to the embryo formation, the egg has to be reported as non-fertile and removed from incubation. During the 7 years of study, out of the 1347 eggs used for incubation, 532 (40%) non-fertile eggs have been removed.

The amount and percentage of eggs with dead embryos that were removed after the 1^{st} and 2^{nd} biological examination – The death of the embryo during various development stages can occur due to certain nutritional factors (fodder rations energo-protein and vitamin-mineral unbalanced) and also due to several incubation faults. Therefore, during the 7 years of study we have noticed that out of the 1347 eggs used for incubation, 217 eggs with dead embryos (16%) were removed from incubation.

The incubation percentage – the statistics made over the 7 years of study reveal that, out of the total amount of 2544 eggs obtained from all the ostrich females, there were selected for incubation 1346 eggs, which represents an average incubation percentage of 53%. The best results were obtained in 2003, when out of the 339 eggs, 209 of them were used for incubation; also, in 2004, when out of the 391 eggs, 244 of them were used for incubation, which results in a 62% incubation percentage. The lowest results were obtained in 2005, when out of the 307 eggs, only 58 were used for incubation, resulting in a 19% incubation percentage. These unsatisfactory results were caused by the poor food quality and lack of rational ostrich feeding during the breeding and egg-laying period, which led to a high degree of the lack of male libido and therefore many eggs were infertile.

The hatching percentage – during the period of study, out of the total of 2544 eggs, 1346 eggs were used for incubation, out of which only 597 healthy chicks (44%) hatched.

The chicks viability dynamics – upon hatching, the ostrich youngster begins a very difficult **starting period** which lasts 21 days; during this period, the chick has to fight stress and microclimate factors, and also various bacterial infections that can occur. During the starting period, the breeder will take into account the following:

- the clinical status of chicks (the button chord, the viteline sac resorption degree, the status of the legs etc.)
- the microclimate conditions inside the shelter
- the bedding

Out of the 597 hatched chicks, only 347 of them managed to survive beyond the age of 3 months, therefore the viability percentage was 58%; the chicks death rate was caused by various reasons: weak chicks that were helped to exit the egg shell, failure of viteline sac absorption and peritoneal infections, button chord infections, indigestions through overloading due to the eating of the bedding hay, cloacal prolapse or catarrhal gastroenteritis.

The dynamics of eggs production and hatched chicks for several female ostriches that have manifested a high production rate – 9 ostrich females with a production rate above the yearly average during the 7 years of study have been taken into account; the conclusion was that in 2007 there were obtained the best egg production, that is, 473 eggs out of which 141 chicks have hatched (30% hatching percentage).

The monthly and seasonly eggs production dynamics – the ostriches' egg-laying season begins in March and ends in September – October, but some females start laying eggs even in January, depending on the quality of the fodder. The best eggs production usually occurs during summer with minor differencies from year to year.

The monthly dynamics of the faulty eggs – in order to know the egg faults that need to be taken into account when removing them from incubation, there have been considered several morphologic factors (the egg's weight, shape, integrity of the component parts) as well as several modifications of the biochemical content of the egg. By observing the monthly dynamics of the faulty eggs, we notice that there isn't a higher frequency in a certain month or season.

The dynamics of the female breeding cycle and the first eggs – the female libido starts in March, then 2 weeks after the first copulations the females start laying eggs once every 48 hours. The quality of the fodder which should contain protein and vitamin-mineral components is very important for the starting of the copulation season and also for the ritmicity of the eggs production.

The dynamics of male breeding cycle and copulation – by analysing the male behaviour, the period when they start breeding, the intensity of the libido and the copulation during the period of study, we find that out of the 8 males used for reproduction, 3 were removed because they had a low libido, were copulating less often, and the resulted eggs had a very low fertility percentage. Therefore, the overall fertility percentage of the reproductive cell was between 17% (M 171) and 38% (M 146) and a female fertility percentage was between 0% (F 145) and 33% (F

168). The males with a high potential which manifested an obvious libido over the entire period of study were: M 146; M 137; M 189; M 131.

Contributions to the improvement of the ostrich chicks raising technology – the ostrich fodder needs to be very nutritious and rich in carbohydrates and protein + aminoacids, vitamins and minerals, as well as fats, oils and water. Most of the times, the ostrich fodder is composed of a rich mixture of fodder plants, such as: alfalfa, clover, straw, strains of sunflower, corn, soy, barley, oatmeal, everything being well ground and mixed.

Comparative aspects regarding the ostrich chicks raising technology

Shelters and microclimate – the most important care will be provided to the newly-hatched chicen which are helpless and unable to stand on their feet:

- during the 0 – 7 day period, the chicks will not be fed in order to favor the yolk consumption
- there will be added vitamins, minerals, and antibiotics into the chicks' water
- special attention will be given to the position of the chicks' legs, which will be tied until the chick is able to walk by itself
- the chicks will be weighted on a daily basis because their weight decreases as they consume the vitelus

During the 7 – 30 days of age, the chicks will be accomodated into portable enclosures, which need to be well heated and ventilated. The termic confort is provided with electric lamps. The pavement into the enclosure needs to be covered with a rubber carpet in order to prevent chick slipping and eating of the bedding hay. The green, well ground and mixed with corn flour fodder is preferred and well tolerated by the chicks, when it's served in small daily rations. The granulated food will be fed to the chicks 3 times a day in order to avoid the bacterial enteritis. The ostrich chicks gain 0.5 kg in weight in the 3rd week of life. During the starting period the hay or sand bedding is not recommended because the chicks can eat it out of curiosity and will suffer severe indigestions during to overload. The fodder mixture needs to contain ground carrots and boiled hard eggs with shell included. The manure is very important during this period because it can show the first manifestations of a digestive condition. In order to prevent chick lameness and leg aches, the drink water will contain sodium selenite. Also, the chicks will be disinfested internally against Coccidiosis and vaccinated against the Newcastle disease.

The raising of the ostrich chicks aged between 1 and 3 months – during this period the ostrich chicks can be let outside in exterior paddocks when the weather is sunny and warm, but during the night and when the weather is cold they need to be kept inside the shelters.The paddock needs to have an area covered with grass and also areas with protection against the sun heat. The fodder will be always available so that the ostrich chicks can eat all the time.

The dynamics of chicks weight upon hatching – during a period of 6 years there were weighted batches of 50 eggs that have been sent to incubation, carefully observing the maximum and minimum weight of each egg. According to the statistics, out of the 300 eggs weighting between 1421 – 1629g, there were obtained chics between 632,8 and 1084,3g in weight, therefore a yield between 43,8 – 66,5% out of the weight of the egg.

The dynamics of the weight gain and average daily gain – according to the statistics, there were obtained the following results: during the 1st week of life, the ostrich chick loses approximately 1/3 its body mass (20 - 30%) which actually represents the weight of the yolk sac that's being absorped. The re-gain of the initial weight is proportional to the incubation period. The stury revealed a progressing increase of the chicks weight upon hatching, therefore after the 6 years of study we found the following results:

- the re-gaining of the chick's weight was achieved at the end of the 2nd week after hatching
- the average daily fodder consumption ranges between 15 – 50g with a daily average gain of 23g
- the daily average gain in the 8 weeks from hatching was 128.3g
- the weight of the ostrich chick in the 8th week of life was 6922g

Illnesses of the ostrich chicks and growth problems – the adult ostriches are resilient birds, less prone to diseases, but the chicks and youngsters need more care; it's well known that 90% of the chick deaths occur during the starting period. Among the most common illnesses there are: the infection of the yolk sac, feet and toe deformities, cloacal prolapse, diarrhea and stomach infections or swallowing of foreign objects.

The lack of yolk sac absorption and infection of the yolk sac – just before breaking the egg shell, the ostrich chick absorbs the yolk sac from the ombilical chord into its abdomen; the yolk weight is up to 1/3 out of the weight of the chick; the yolk is the food source during the 1st week of life. The infection of the yolk sac is the most frequent cause of the newly-hatched ostrich chicks' death. The infection of the ombilical button and of the yolk sac occurs due to the very frequent chicks handling by the human operator when their hands are not clean enough; also this occurs when the incubator or the hatching unit are poorly sanitized, or the rubber carpet is not clean and sanitized. The symptoms of the yolk sac infection are:

- the chick walks and stands similarly to a penguin
- a touch of the chick's abdomen reveals hardness and the fingers don't easily get wrapped onto the chick's abdomen as they should
- the color of the chick's abdomen becomes dark, bluish-green
- the chick's apetite decreases

- the removal of the infected yolk sac requires surgery by removal of the ombilical button and also of the infected yolk sac

The PHD Thesis contains 189 pages, with 66 images, 40 tables and 7 bibliographic pages.

Also, the following documents are attached to the thesis: Introduction – 8 pages; Synopsis – 8 pages; Table of Contents – 6 pages.