Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznan, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wroclaw.

ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2003
Volume 6
Issue 2
Series ANIMAL HUSBANDRY

Copyright © Wydawnictwo Akademii Rolniczej we Wroclawiu, ISSN 1505-0297
SZCZERBIŃSKA D., MAJEWSKA D., TARASEWICZ Z., DAŃCZAK A., M. LIGOCKI 2003. HATCHABILITY OF EMU (*DROMAIUS NOVAEHOLLANDIAE*) EGGS IN RELATION TO INCUBATION TEMPERATURE **Electronic Journal of Polish Agricultural Universities**, Animal Husbandry, Volume 6, Issue 2.
Available Online http://www.ejpau.media.pl

HATCHABILITY OF EMU (*DROMAIUS NOVAEHOLLANDIAE*) EGGS IN RELATION TO INCUBATION TEMPERATURE

Danuta Szczerbińska, Danuta Majewska, Zofia Tarasewicz, Alicja Dańczak, Marek Ligocki
Department of Poultry and Ornamental Bird Breeding, Agricultural University of Szczecin, Poland

ABSTRACT
INTRODUCTION
MATERIALS AND METHODS
RESULTS AND DISCUSSION
CONCLUSIONS
ACKNOWLEDGEMENT
REFERENCES

ABSTRACT

The aim of the study was to assess an effect of incubation temperature (36.4, 36.7, and 37.1°C) on hatching performance of emu. The fewest dead embryos (13.7%) were found in group I with the lowest incubation temperature. Raising the temperature by 0.3°C and 0.7°C in, respectively, group II and III reduced the hatchability indices, primarily due to an increased rate (by approx. 12%) of dead embryos in both groups. Temperature significantly influenced the duration of incubation period, as well as duration of hatching. Incubation at the highest temperature took the shortest time (49.9 days), whereas that at the lowest temperature lasted longest (51.5 days). A reversed pattern was found in the case of hatching duration, which at the higher temperature expanded by 282 minutes in group II and by 406 minutes in group III, as compared with group I.

Key words: emu, incubation temperature, hatchability

INTRODUCTION

Pioneering emu farms were started in Western Australia in the 1970s [13]. Such a short time span of emu farming history leads to the fact that a number of questions on raising and reproduction of these birds still remain unanswered. The shortage of information in this range results also from limited availability of emu eggs, which are seasonally laid in poor quantities, thus being very expensive. Hence, any experiments carried out on emu eggs are very costly. Hatchability index of emu eggs reported in the literature tend to be very variable and

relatively low, as compared with other farmed fowl species, ranging from approx. 36% to 73% [4, 5, 9, 11, 18]. This results also from the fact that the technology of artificial emu egg incubation has not been fully developed so far, and further studies are needed to definitely determine which incubation parameters of temperature, humidity, or egg rotation, suggested by many authors, should be applied.

Minnaar and Minnaar [14] stated that the best hatchability indices can be achieved if the hatching takes place at a temperature between 35.8 and 36.4°C and at a relative humidity of 24 to 35%. A lower temperature range during incubation, i.e. 34.9 to 36.3°C, are acceptable according to Brake and Roseland [3]. According to Stewart [17], incubation temperature should by slightly higher, in the range 36.0-36.7°C, with humidity reaching as much as 40%. Majewska [10] carried out emu eggs incubation at temperature 36.4°C and humidity 35% and achieved between 70% and 82% hatchability from fertilised eggs. Kinder [9], on the other hand, obtained as little as 36.6% in similar conditions. The literature lacks comprehensive comparative studies that would report on application of varied temperature throughout incubation of emu eggs.

Therefore, it seems purposeful to determine en effect of temperature applied during hatching on the indices of emu egg hatchability.

MATERIALS AND METHODS

The investigations took place from the end of 2001 to beginning of 2002 on a private emu breeding farm. A flock of 20 birds in their 5th year of laying period were held in pairs, managed in the semi-intensive system, fed *at libitum* on balanced mixes, both during the resting period and during the laying season. The mix formulated to be fed during reproductive seasons was introduced 4 weeks before the expected onset of laying season. The nutritional value of the mix corresponded to dietary requirements of the birds in the reproductive season; it had low energetic value (10.4 MJ), high protein content (22%), high level of exogenous amino-acids (lysine- 11.2 g, methionine+cystine- 7.55 g), of vitamins (A – 15,747 IU, D_3 – 3,800 IU, and E – 41 mg), as well as minerals, especially calcium and available phosphorus (respectively 3.0% and 0.6%), which was in accordance with recommendations by Scheideler [15, 16].

During breeding, each pair was assigned a separate compartment in the shed and a paddock, which facilitated both individual control of laying and a proper laying performance evaluation for each hen in the flock. Eggs for hatching were collected three times a day, in the morning, late in the afternoon, and at night, for 15 days. On each collection, egg weight and laying date were recorded and the eggs were marked with subsequent numbers and stored at 16°C.

Hatchability evaluation was carried out in 4 sets comprising 179 eggs collected between January and April. In each set, eggs collected during a 15-day period were randomly distributed to three electronically controlled cabinet incubators in which the following incubation temperatures were applied: 36.4°C (group I), 36.7°C (group II), and 37.1°C (group III). Directly before setting, the eggs were disinfected with formaldehyde fumes for 30 minutes. Relative humidity inside the setting chamber was 30%, while in the hatching chamber it was raised initially by 10%, and then by further 20% on the moment when first chicks broke through the shell. The eggs were incubated in horizontal position being turned automatically 180° every hour.

Every week of incubation, the eggs were weighed in order to keep track of their weight loss, and were candled using a device fit with a noctovision camera. Time of hatching was recorded (span from the chick breaking the shell until leaving it). The cases were also recorded when chicks needed help to leave the shell. Helping the chicks (basing on own observations from previous experiments) was undertaken in two events only:

- if a chick had not succeeded to break through the shell within 48-50 hours from breaking the air chamber membrane; in this case a small opening was made in the shell to allow fresh air in;
- if a chick had not made any progress in hatching within 18-20 hours from shell breaking.

As soon as a chick had hatched, the chick, the foetal membranes, and the metabolite litter were weighed in order to calculate their proportions in the total egg weight. On the completion of the hatching, the eggs containing dead embryos were opened. The indices of hatchability from set and fertile eggs were calculated as well as the rate of dead, crippled, and weak embryos. The collected data were analysed statistically using one-way ANOVA and Duncan test.

RESULTS AND DISCUSSION

The laying season of the experimental flock of birds lasted for nearly 5 months, the first egg laid mid December, the last beginning May. Analysing the number of eggs per hen, it was varied, ranging from 15 to 29 eggs. The

number of eggs per hen for the entire breeding stock in relation to the flock's average was 23 eggs, thus lower than that considered as an average (30-40 eggs) by Minnaar and Minnaar [14]. These authors, however, did not specify the age of the hens which would reach such level of laying performance, neither their laying season span. Emu, birds of a long lifespan, can be farmed for several years. The studies by Szczerbińska [18] demonstrated that the number of eggs and their weight increase with the age of a bird.

Egg weight decreased gradually by approx. 2% each week of incubation, therefore weight loss in individual groups on subsequent weighing dates were similar and did not differ depending on incubation temperature (Table 1). According to Delfel and Roseland [7], the best incubation conditions for emu are if an egg loses during the incubation 12 to 15% of its initial weight. Minnaar and Minnaar [14] stated that such loss is attained if the incubation is carried out at 35.8 to 36.4°C and at a relative humidity 24 to 35%. In our experiment, setting incubation temperature in the range 36.4 to 37.1°C, at the same level of humidity, did not result in changes in weight relative loss during incubation, which remained in the narrow range 13.4 to 13.8%.

Table 1. Egg weight loss during incubation (%)

Days of incubation	Group		
	I	II	III
7	2.1±0.48	1.9±0.27	2.1±0.26
14	4.1±0.71	3.9±0.54	4.1±0.56
21	6.0±1.05	5.9±0.80	6.1±0.79
28	7.9±1.23	7.8±1.06	7.9±0.84
35	10.0±1.78	9.8±1.32	9.8±1.03
42	11.8±1.89	11.6±2.28	11.9±1.35
48	13.8±2.11	13.4±1.76	13.4±1.56

Egg fertilisation rate in the flock was very high as for this avian species, which demonstrated that the males and the females had been well mated (Table 2). Similar fertilisation rates (88-92%) were achieved by Majewska [10] in a flock of 4-year-old emus. Fertilisation indices not only depend on the age of birds, but also on laying season and mating system. So far, most farms have been managing monogamous pairs of emu; what is more, our earlier observations showed that a proper arranging reproductive pairs may pose some difficulties. Mated birds do not always accept each other, sometimes fight and, consequently, males do not service the hens. Deciding to allow the birds to mate freely in their first mating season, rather then applying individual mating, the breeder can achieve higher fertilisation rates [10, 12].

Table 2. Hatching performance in relation to applied temperature

Item	Group		
	I	II	III
Number of set eggs	66	62	51
Number of fertile eggs	62	54	45
Rate of fertile eggs (%)	93.9	87.1	88.2
Dead embryos (%)	13.7	25.8	25.5
Crippled and weak hatchlings	9.0	3.3	13.7
Hatchability from set eggs (%)	71.2	58.1	49.0
Hatchability from fertile eggs (%)	75.8	66.7	55.6

The best hatching performance was attained within group I, where the temperature 36.4°C was maintained throughout incubation. Raising the temperature to 36.7°C in group II and to 37.1°C in group III, led to reduced hatchability indices, primarily due to an increased rate (by about 12%) of dead embryos found in both groups (Table 2). The literature lacks detailed information of emu embryogenesis, hence difficulties in our experiment to establish a precise time and curve of embryo dying; such information, as it is known, are very important in embryopathology [1]. Interpretation of the results is also difficult due to the lack of studies on the causes underlying embryo deaths; not much can be done beyond some comparisons with other species of domestic birds. According to Borzemska and Kosowska [2], death rate after hatching at a level of 7.5 to 22%, depending on the species, breed, and farming goal, are considered physiological. Borzemska [1] reported that increased mortality of embryos is caused also inadequate thermal conditions of incubation. According to the author, to high an incubation temperature of chicken eggs, persisting for a longer period of time, increases embryo

mortality especially around the 16th day of incubation. In our studies, in groups II and III, most embryos died at the end of incubation. It can therefore be presumed that even slightly elevated temperature during such a long, compared with other bird species, incubation period may result in increased rate of dying embryos. The literature also lacks comparative data on the effect of various temperatures of incubation on emu hatchability, hence discussion at this point is difficult. For ostrich, the species biologically most similar to emu, the best hatchability from fertilised eggs, as well as the highest rate of healthy chicks were achieved at incubation temperature 36.4°C [8], which was similar to the results of experiment. It may be therefore presumed that such temperature represents an optimum for either species, although the problem requires further investigations.

Incubation temperature significantly influenced its duration, as well as chick hatching duration (Table 3). The shortest time, 49.9 days, took the eggs to incubate at the highest temperature (37.1°C), while the longest incubation, 51.5 days, was at the lowest temperature (36.4°C). Deeming et al. [6], who observed hatching of ostrich eggs, found that temperature decreased by 1°C results in extended incubation period by 2 to 2.5 days. A reversed trend was observed in the case of hatching time, which expanded in groups II and III by, respectively, 282 and 406 minutes, compared with group I. Although higher temperature of incubation resulted in its shortening, the chicks may have set out to breaking shells being unprepared for it, hence considerably extended time of hatching. In all, 7 chicks were helped to hatch during the experiment. Their highest rate was found in group I (8.6%), whereas the index decreased in groups II and III to the values of, respectively, 5.6 and 4.0%.

Table 3. Hatching evaluation in relation to applied incubation temperature

Item	Group		
	I	II	III
Egg weight (g)	662.9±68.8	670.3±68.5	650.8±47.3
Duration of incubation (hours)	1236.1a±46.7	1227.4a±31.4	1197.5b±18.6
Duration of incubation (days)	51.5	51.1	49.9
Hatching duration (minutes)	547a±299	829b±338	953b±338
Number of hatchlings:	47	36	25
Self hatched chicks	43	34	24
Assisted hatchings	4	2	1
Weight of hatching litter* (%)	2.07a±1.33	1.78ab±0.91	1.39b±0.48
Weight of hatchling, absolute (g)	446.8ab±50.3	463.8a±49.9	428.0b±38.6
Weight of hatchling, relative (%)	67.2±2.98	67.7±1.96	66.4±3.29
Deaths until 3 weeks of age (%)	4.3	8.0	2.8

a, b – means in rows marked with different letters differ significantly ($p < 0.05$).
*Remainings of foetal membranes, metabolites.

Relative chick weight in all the groups remained similar (66.4 - 67.7%) and was similar to the values attained by other fowl species, especially by chickens and quails [19]. According to Minnaar and Minnaar [14], the weight of a healthy chick should represent about 2/3 of initial egg weight. These authors also stated that chicks of a relative weight below 61% should be considered as dehydrated, whereas those exceeding 69% of egg weight should be considered "overhydrated", which is often indicated by swelling of chicks bodies.

CONCLUSIONS

1. The best hatchability from fertile eggs was achieved in the group of incubation temperature 36.4°C (75,8%), while worse results, by respectively 9.1% and 20.2%, were recorded in groups of temperature 36.7 and 37.1°C.
2. Thermal conditions of emu egg incubation significantly influenced its duration as well as chick hatching time. Application of higher incubation temperature resulted in reduced incubation duration with extended time of the hatching process.

ACKNOWLEDGEMENT

The project was financed by the State Committee for Scientific Research, project no. 5 P06E 042 19

REFERENCES

1. Borzemska W., 1984. Vademecum chorób drobiu [Guide to Poultry Diseases]. PWRiL, Warszawa [in Polish].
2. Borzemska W., Kosowska G., 1997. Ważniejsze problemy w patologii lęgów u drobiu [Major problems in poultry incubation pathologies]. Zesz. Nauk. Prz. Hod. 31, 25-30 [in Polish].
3. Brake J., Roseland B.L., 1995. Incubation and hatching [in: Ratite Encyclopedia. Ed. C. Drenowatz.].Ratite records Inc., San Antonio, 103-116.
4. Dańczak A., Tarasewicz Z., Szczerbińska D., Adamirowicz D., Ligocki M., 1997. Evaluation of emu (*Dromaius novaehollandiae*) egg hatching results. [Ocena wyników lęgów jaj pochodzących od emu (*Dromaius novaehollandiae*).] Zesz. Nauk. Prz. Hod. 31, 225 [in Polish].
5. Dańczak A., Majewska D., 1999. Emu (*Dromaius novaehollandiae*) hatch success and control on hatchling survival. Adv. Agric. Sci. 6(1), 25-30.
6. Deeming D.C., Ayres L., Ayres F.J., 1993. Observations on the commercial production of ostrich (*Struthio camelus*) in the United Kingdom: Incubation. Vet. Rec. 132, 7, 627-631
7. Delfel S., Roseland B., 1993. Incubation and hatching tips. AEA News 10, 1, 6-8.
8. Horbańczuk J.O., 2000. Doskonalenie technologii sztucznych lęgów strusia afrykańskiego (*Struthio camelus*) z uwzględnieniem aspektów biologicznych [Improving the technology of artificial incubation of ostrich (*Struthio camelus*) eggs with reference to biological aspects]. Rozpr. Pr. Mat. Zootech., Zesz. Spec. 10, IGiHZ PAN, Warszawa [in Polish].
9. Kinder L., 1993. Emu today and tomorrow. University of Arkansas Emu Research, Nardin, Oklahoma, 164-167.
10. Majewska D., 1999. Ocena wylęgowości emu (*Dromaius novaehollandiae*) w okresie adaptacji ptaków do warunków krajowych [Evaluation of emu (*Dromaius novaehollandiae*) hatchability during the period of adaptation of birds to domestic environment]. Doct. thesis. AR, Szczecin, unpublished [in Polish].
11. Majewska D., Szczerbińska D., Dobrowolski W., Tarasewicz Z., Wnukiewicz A., Romaniszyn K., 2002. Ocena wylęgowości jaj emu (*Dromaius novaehollandiae)* zależnie od czasu ich przechowywania [Evaluation of emu (*Dromaius novaehollandiae*) egg hatching results in relation to storage time]. Rocz. Nauk. Zootech., Suppl. 16, 79-84 [in Polish].
12. Majewska D., Szczerbińska D., Tarasewicz Z., Dańczak A., Romaniszyn K., 2003. Assessment of hatching rate of emu (*Dromaius novaehollandiae*) in the first year of egg laying. Acta Sci. Pol. Zootech. 2 (2), 57-63.
13. Minnaar M., 1998. The Emu Farmer's Handbook. Vol. 2. Nyoni Publishing Company, Groveton, Texas.
14. Minnaar P. Minnaar M., 1993. The Emu Farmer's Handbook. Induna Company, Groveton, Texas.
15. Scheideler S.E., 1996a. Nutrition and physiology of ratites. Canadian Ostrich 12, 10-31.
16. Scheideler S.E., 1996b. Essential nutrients in the emu diet – sources and interactions. AEA News, Summer, 36-37.
17. Stewart J.S., 1992. Ratite incubation. Proceedings of the Association of Avian Veterinarians, New Orleans, 336-339.
18. Szczerbińska D., 2002. Charakterystyka użytkowości reprodukcyjnej emu (*Dromaius novaehollandiae*) ze szczególnym uwzględnieniem ultrastruktury skorupy i jej związku ze wskaźnikami wylęgowości jaj [Characterisation of reproductive performance of emu (*Dromaius novaehollandiae*) with particular reference to eggshell ultrastructure and its association with the indices of egg hatchability]. Rozpr. AR Szczec. 210 [in Polish].
19. Wilson H.R., 1991. Interrelationships of egg size, chick size, posthatching growth and hatchability. World's Poult. Sci. J. 47, 5-20.

Danuta Szczerbińska, Danuta Majewska, Alicja Dańczak, Zofia Tarasewicz, Marek Ligocki
Department of Poultry and Ornamental Bird Breeding
Agricultural University of Szczecin
Doktora Judyma 20, 71-460 Szczecin, Poland
d.szczerbinska@biot.ar.szczecin.pl

Responses to this article, comments are invited and should be submitted within three months of the publication of the article. If accepted for publication, they will be published in the chapter headed 'Discussions' in each series and hyperlinked to the article.
