ROSS

Ross Tech 98/35

Investigating Hatchery Practice

Successful production of day-old chicks requires that good hatchability be achieved consistently. Fertile eggs must be supplied with the correct ventilation, temperature, humidity and turning so that the biological needs of the developing embryo are adequately satisfied. Failure to provide the correct conditions results in depressed hatchability and changes in the pattern of embryo mortality. For this reason, the procedures described in this Ross Tech are an invaluable part of hatchery management and contribute useful information to the routine quality control programme.

PLANNING AND ORGANISING AN INVESTIGATION

Hatchability is affected by the conditions experienced by eggs from oviposition until hatching. Therefore any investigation should begin as soon as the eggs are laid and should continue throughout the process until the hatching of the day-old chicks. Careful planning will ensure that the material examined is representative of the system as a whole. The result of an investigation will be to suggest alternative management within the process. Quality control routines must then be adapted to prevent recurrence of problems.

AREAS OF INVESTIGATION

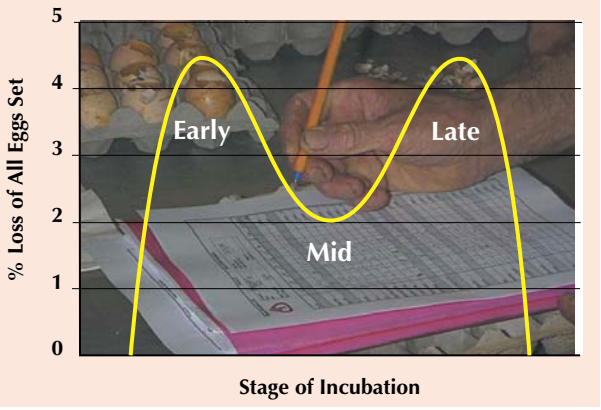
Production of first quality chicks is the result of a process during which eggs are collected, stored, transported and incubated. The process may fail at any stage. Specific areas of investigation described in this Ross Tech include:

- Analysis of embryonic mortality patterns and developmental abnormalities by examination of hatch debris.
- Identification of causes of incubator clears i.e. infertile eggs or early dead embryos.
- Measurement of egg weight loss during incubation.
- Monitoring of the temperature profile:
  - from hen to incubator i.e. during egg handling,
  - during incubation.

EXAMINATION OF HATCH DEBRIS

Embryonic mortality in broiler parent stock tends to follow a predictable pattern. Mortality will be high in the early stages (i.e. 0-6 days), as non-viable embryos die. There is then a relatively stable middle period (i.e. 7-18 days), followed by another mortality peak as the chicks prepare to hatch (i.e. 19-21 days). (See Figure 1).

FIGURE 1: PATTERN OF EMBRYONIC MORTALITY AT VARIOUS STAGES OF INCUBATION



The exact levels of the 2 peaks will change as the parent flock ages. Typical levels of mortality are given in Appendix 3.

When unhatched eggs are being examined at the end of incubation, it is important to ensure that they are a representative sample of all the eggs set at that time. Some eggs may be lost at candling (i.e. incubator clears and rots) and so, it may be impossible to relate a sample of eggs saved to the entire setting of eggs. The ideal procedure is to save and examine all unhatched eggs from 8-10 whole trays, equivalent to 1000-1500 eggs set. If unplanned samples (e.g. 2 Keyes trays taken at random on the day of hatch) are the only materials available, the results obtained must then be corrected proportionally to the percentage dead-in-shell of all eggs set.

The sample of eggs to be opened must be planned and organised as described in Appendix 1 and the examination should proceed as follows:

— Select all the trays required for analysis. (See Figure 2).

— Count first quality chicks, culls and dead-on-tray chicks on each tray, and record the numbers of each on Form 1.

— Label Keyes trays with flock code and hatch tray numbers.

— Find the remaining unhatched eggs, transfer to the labelled Keyes trays, count and record the number on Form 2. The hatcher trays can then be released for washing.

FIGURE 2: SAMPLE HATCHER TRAYS SAVED FOR INVESTIGATION

— Working through each tray within the sample, open each egg. (See Figure 3). Classify the contents according to when the embryo died and whether or not there is bacterial contamination. Record any developmental abnormalities. Descriptions of the different categories are given in Appendix 2. Sort eggs by developmental stage on to Keyes trays, and then record number of eggs in each category, by tray on Form 2.

FIGURE 3: OPENING UNHATCHED EGGS IN THE HATCHERY

— Total the number of eggs in each category for every flock and then calculate the percentage of the total number of eggs set.

— Plot the results, comparing them with the targets relevant for the particular flock age. (See Appendix 3). The categories having the greatest deviation from target indicate where problems are occurring. See Interpretation of Results, page 7, for an example.

IDENTIFICATION OF INCUBATOR CLEARS

Incubator clears include not only infertile eggs but also eggs where some development has occurred. It is important to distinguish true infertility from early embryonic mortality in order that appropriate action may be taken. In hatch debris, it is often difficult to distinguish infertile eggs from those which have experienced very early embryonic mortality. In these situations, it is better to look at either unincubated or partly incubated eggs.

Hatch Debris

Identification of infertile eggs after 21 days of incubation can be difficult. The often- described 'bright, white dot' (i.e. germinal disc) has usually degenerated, as may have the yolk membrane, especially if mottling has been a problem when the eggs were fresh. After 21 days of incubation, fertile eggs which have not re-commenced development after storage, and infertile eggs are easily confused, since both lack membrane development. For this reason, therefore, it is better not to try to distinguish between infertile and very early dead embryos in hatch debris, but to note if infertiles plus very early deads exceed target. More accurate examination may then be made of unincubated or partly incubated eggs.

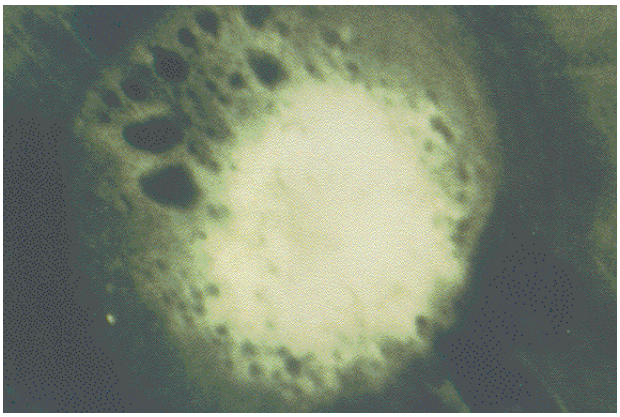
Unincubated Eggs

Opening unincubated eggs will, with practice, give a rapid and timely indication of true flock fertility. It is possible to distinguish between fertilised and infertile eggs, because, after fertilisation, the egg spends 18-20 hours in the oviduct, during which time cell numbers increase from one to approximately 60,000.

FIGURE 4: OVIDUCT AND OVARY OF A BROILER PARENT HEN IN LAY

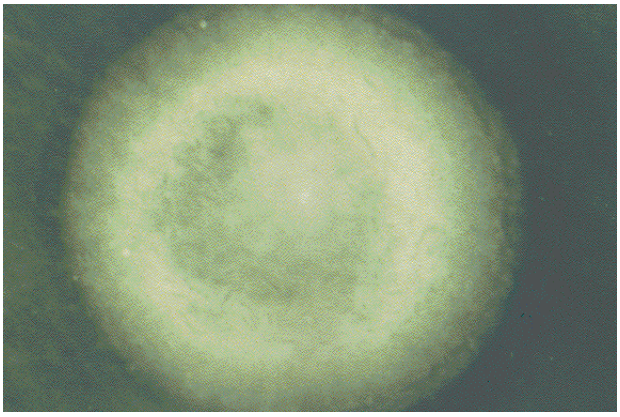
Figure 4 shows the oviduct and ovary of a broiler parent hen in lay. After ovulation, the blastodisc i.e. unfertilised female germ cell, will be fertilised at the infundibulum and the yolk and its fertilised blastoderm will then spend 18-20 hours passing down the oviduct, where it will be covered with albumen, surrounded by the shell membranes and then by the shell. By the time that the egg is laid, i.e. at oviposition, there will be 60,000 cells in the blastoderm and these will be starting to organise into groups i.e. gastrulation.

FIGURE 5: UNFERTILISED GERMINAL DISC



The embryonic development which occurs whilst the egg is still inside the hen simplifies identification of infertility prior to incubation. An unfertilised germinal disc will show little evidence of any structure, (see Figure 5), when compared with a fertilised blastoderm with its' pronounced ring structure. (See Figure 6).

FIGURE 6: FERTILISED BLASTODERM SHOWING ORGANISED RING STRUCTURE



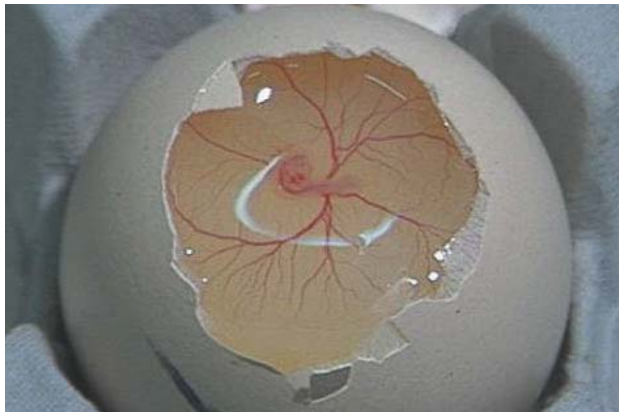
The difference is visible even when unmagnified. Examination at this stage will also allow identification of any abnormalities in the internal structure of the egg. Mottling of the egg yolk, a disturbance of the vitelline membrane, is usually caused by stress. It will always make the eggs more susceptible to bacterial contamination and early embryonic mortality. Thin watery albumen will also reduce hatchability. This is usually due to Infectious Bronchitis or prolonged egg storage. Cottonseed meal as a contaminant of feed can cause the egg yolk to become thick and viscous and will also reduce hatchability.

One hundred eggs per house should be examined to obtain a reliable estimate of fertility. The test requires destruction of potential hatching eggs, but unsettable cracked and dirty eggs may be used without biasing the results. The easiest method of examination is to break the shell and tip the contents into one hand, rolling the yolk over until the blastoderm can be seen. There can be difficulties when birds are on a wheat-based diet because the pale yolk colour offers little contrast with the blastoderm. It is therefore important to practise identification using eggs of known fertility status and infertile commercial eating eggs. Although considerable natural variation occurs within each category, undue emphasis should not be given to small differences.

Partly Incubated Eggs

The fertility test undertaken on partly incubated eggs also involves the destruction of some potential hatching eggs, but is easier and requires considerably less practice than that carried out on unincubated eggs. Once again, a 100-egg sample per flock is the minimum requirement, although it is usually more practical to use a full setter tray of up to 150 eggs. Eggs should have been incubated for 3-5 days prior to examination. Each egg is opened at the air cell so as to avoid any disruption to the egg contents. At 3 days, most embryos will be alive with well developed circulatory systems. (See Figure 7).

FIGURE 7: EMBRYO AFTER 3 DAYS OF INCUBATION



There is little *post mortem* deterioration in the early dead embryos, because the eggs have spent a relatively short time in the incubator.

Infertile eggs can be clearly distinguished from those that were fertilised, but failed to begin to grow again after storage by absence of membrane growth; the germinal disc is clearly visible as a bright white dot. (See Figure 8).

Figures 5 and 6 are reproduced by kind permission of Dr G J Wishart, University of Abertay.

FIGURE 8: INFERTILE EGG AFTER 3 DAYS OF INCUBATION

After one day's growth, there is a ring of cream coloured membrane measuring about 0.5cm in diameter. (See Figure 9).

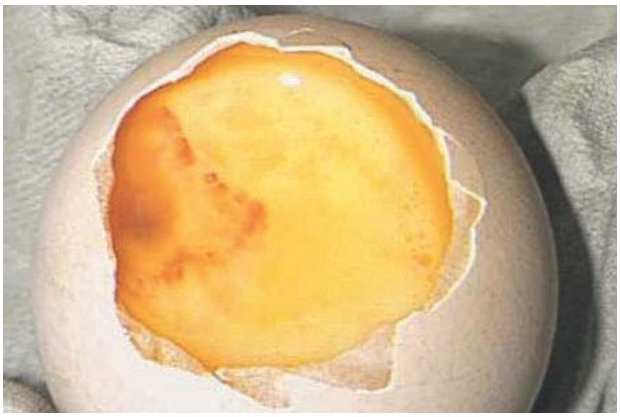
FIGURE 9: EARLY DEAD EMBRYO SHOWING ONE DAY'S DEVELOPMENT

After 2 days of incubation, the cream coloured membrane will cover most of the top surface of the yolk. (See Figure 10).

FIGURE 10: EARLY DEAD EMBRYO SHOWING 2 DAYS OF DEVELOPMENT

Embryos, which have died after the circulatory system has developed, are obviously different from living embryos because the blood vessels are fewer in number and darker in colour. (See Figure 11).

FIGURE 11: EMBRYO WHICH HAS DIED AFTER DEVELOPMENT OF THE CIRCULATORY SYSTEM (i.e. at approx. 3 days of incubation)



Egg Weight Loss

Although the egg is often thought of as a closed system during incubation, the embryo is dependent on gas exchange through the shell to supply oxygen and lose excess water and carbon dioxide. The net result of this gas exchange is that the egg should lose weight throughout incubation. Observations across all avian species have shown that the optimum weight loss between the start of incubation and internal pipping (i.e. at approximately 18 days in the domestic fowl), is constant at between 12 and 13% of the initial egg weight.

The potential of the egg to lose weight under given conditions will be determined by the conductance of the egg shell, which is governed by egg shell thickness and porosity, and the egg size (i.e. surface to volume ratio). As egg size increases with flock age, the conductance also increases permitting the same percentage weight loss.

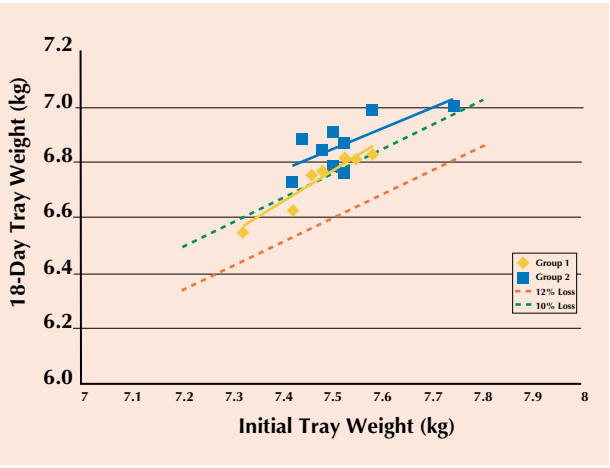
Humidity around, and airflow across the egg will influence the weight lost in the incubator. Optimal conditions will tend to vary with the age of a flock, which is why hatchability and chick quality can be improved by designating setters for eggs from flocks of different ages.

Shell conductance in broiler parents is usually fairly close to the required level, and does not need the extreme intervention found helpful in other species. Duck eggs, for example, must be washed with a slightly caustic solution prior to setting in order to remove the cuticle and so improve gas transfer across the shell.

Plotting the initial versus 18-day weights of full trays of eggs on the target weight loss chart will show if the average weight loss is too high or too low and will also indicate

variability between trays. Weight losses that are very variable, (see Group 2, Figure 12), indicate that conditions within the incubator are uneven, while losses below 10% may signify insufficient airflow across the eggs, or excessive humidity.

FIGURE 12: EGG WEIGHT LOSS DURING INCUBATION, DEMONSTRATING VARIABILITY AND CONSISTENCY BETWEEN TRAYS



Egg weight losses of less than 10% during incubation result in problems with excessive moisture in late dead embryos. Egg weight losses in excess of target tend to be associated with problems of dehydrated chicks.

Temperature Profiles

The availability of miniature, battery-powered, data loggers, which will record temperatures for a pre-set period have made the investigation of egg handling conditions relatively easy. A logger can be placed in the nest box overnight, be collected with the eggs and then follow the entire egg disinfection, packing, cooling, storage and incubation process through to the end.

After initial cooling, eggs must not be allowed to reach a temperature high enough to permit cellular growth of the embryo until placed in the setter. The critical temperature for cellular growth (i.e. Physiological Zero), is just over 21°C.

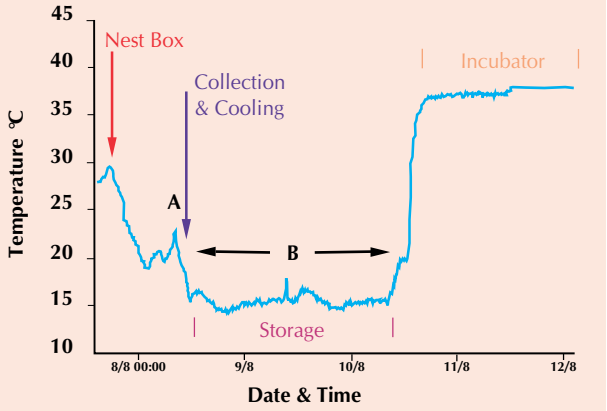
Common problems include:

- Eggs left too long in the nest, allowing them to re-warm when another hen occupies the nest.
- Infrequent collection in automatic nests where eggs are held at house temperature without cooling.
- Eggs packed on to fibre Keyes trays, which only allow very slow cooling.
- Eggs held in the egg store after packing until the end of the working day, rather than being moved into the cooled store immediately.
- Egg store door left open especially during hot weather.
- Temperature control in egg store inadequate, with high diurnal variations in hot weather due to insufficient cooler capacity or poor insulation.
- Trolleys held outside store prior to loading of egg collection vehicle.
- Egg collection vehicle not temperature controlled.
- Farm and hatchery stores held at different temperatures.
- Prolonged pre-warming of eggs, in an environment fluctuating around Physiological Zero.

Any of the above will increase the percentage of early dead and blood ring mortality. The use of data loggers allows the exact problem area to be identified.

Figure 13 demonstrates the use of data loggers in identifying egg handling problems. Two problem situations are illustrated. In the first, Problem A, the temperature of the egg in the nest rose to 23°C, after having fallen to 18°C. In the second, Problem B, the storage temperature to which the egg was subjected, at approximately 14°C, is cooler than optimum for short storage.

FIGURE 13: SAMPLE TRACE FROM DATA LOGGER, INDICATING TEMPERATURE CONTROL FAILURES IN THE EGG HANDLING PROCESS



Temperature loggers can also be useful in evaluating incubation conditions. Temperature extremes and positions within the machines which may not be maintained at correct temperatures will be identified.

INTERPRETATION OF RESULTS

Once all the information has been collected, it must then be analysed. Straightforward diagnoses are rarely possible from this type of information. An exception is in cases of extreme vitamin deficiency and such cases are very unusual.

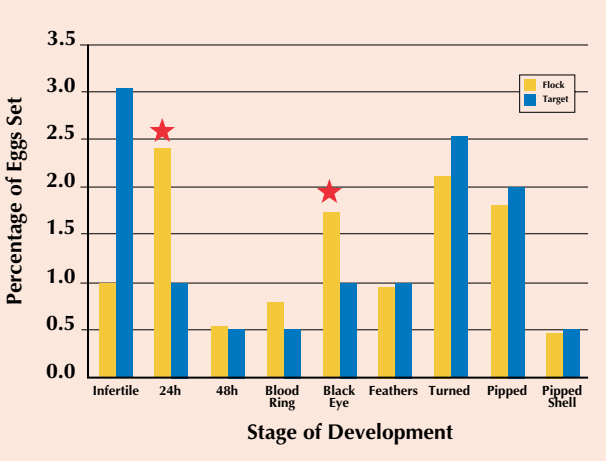
Developmental abnormalities tend to be immediately obvious and memorable, and it is important not to over-emphasise their relevance. The only exception to this is if a trait is seen at high incidence (i.e. most or all of the late dead embryos), in 2 or 3 consecutive trays, where there may be a positional effect indicating uneven incubation conditions in the setter.

The first data to be scrutinised is that obtained by examination of the hatch debris. The number of eggs in each category should be totalled, expressed as a percentage of the eggs set and then plotted against the target for the flock age. If the number of unhatched eggs on each tray is very variable (e.g. the worst tray having twice as many unhatched eggs as the best), then this indicates either uneven holding or incubation conditions, or the presence of trays of washed /floor eggs in the sample. Washed or floor eggs will have a large percentage of 'black eyes' and early rots.

CASE STUDY: INVESTIGATION OF HATCH DEBRIS FROM EGGS OF A 30 WEEK-OLD PARENT FLOCK

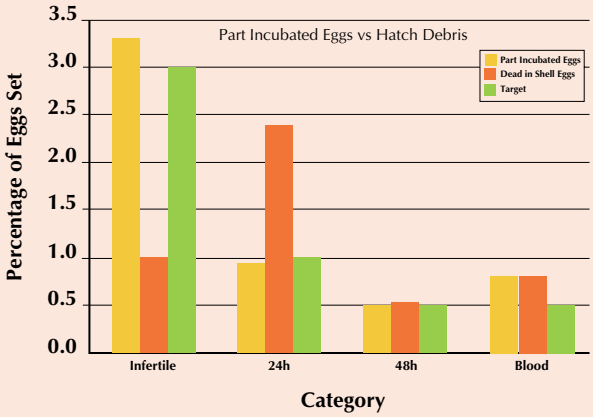
Figure 14 illustrates the mortality pattern for a parent flock which was achieving a reasonably good hatchability of 87%. There were, however, 2 categories where the embryonic mortality was higher than target, and these are indicated by red stars.

FIGURE 14: PATTERN OF EMBRYONIC MORTALITY FROM PARENT FLOCK OF 30 WEEKS OF AGE COMPARED WITH TARGET



The first area of high mortality was at 24 hours of incubation. However, it has already been pointed out that accurate identification of early embryonic mortality is difficult in eggs that have been held at incubation temperatures for 21 days. Sample eggs had also been set 3 days before, and opening these showed that both infertility and 24-hour mortality were in fact normal for the flock age. (See Figure 15).

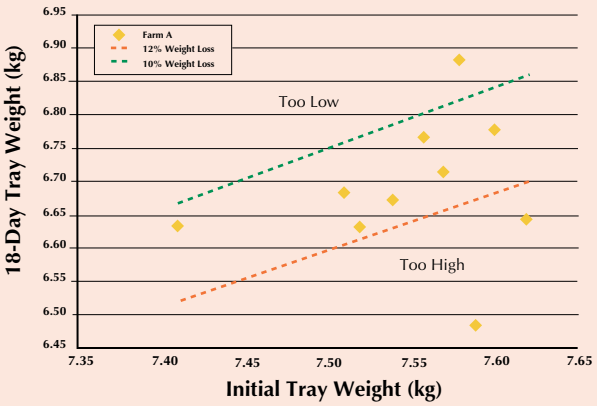
FIGURE 15: COMPARISON OF INFORMATION OBTAINED FROM EXAMINATION OF HATCH DEBRIS AND PARTLY INCUBATED EGGS



The second mortality peak, at the 'black eye' stage, was also relatively high, with the numbers reasonably consistent across all the sample trays. Mortality was associated with heavy contamination; the eggs were discoloured and had a bad odour. An investigation into egg hygiene was therefore required, concentrating on areas where the eggs are likely to be cooling in a dirty environment, or where condensation might be occurring. Levels of developmental abnormalities from this flock were very low (i.e. < 0.5%) and were not significant.

Sample trays of eggs were weighed at setting and at transfer, and the initial and final tray weights have been plotted in Figure 16.

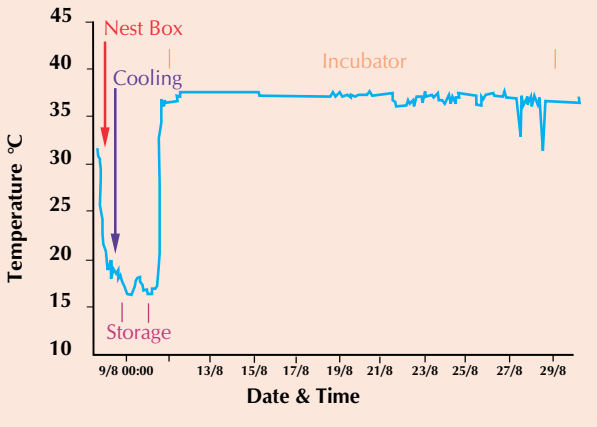
FIGURE 16: EGG WEIGHT LOSS DURING INCUBATION OF EGGS FROM 30-WEEK OLD PARENT FLOCK



Most of the values fell within the target bands, but 3 points fell outside, signifying that either egg shell quality or incubation conditions were variable.

The temperature traces collected using data loggers showed that there were no particular problems. (See Figure 17).

FIGURE 17: TEMPERATURE TRACE OBTAINED THROUGHOUT THE HANDLING AND INCUBATION PROCESS



There was a slight rise in temperature during storage, but temperature did not rise above 21°C.

Investigation on the farm as a result of the incidence of large numbers of rots showed that the depressed hatchability was due to poor nest hygiene. Hatchability improved after programmes of increased egg collections and frequent changes of nesting material were implemented.

Conclusions

Systematic use of the techniques described permits analysis of the incubation process. The information obtained can be used to identify where problems are occurring and how they can be resolved. The results of any changes which are made can be monitored by routine quality control.

Useful Sources of Additional Information

Bakst M.R., Gupta S.K., Potts W. and Akuffo V. (1998). Gross Appearance of the Turkey Blastoderm at Oviposition. **Poultry Science 77**: 1228-1233.

Wilson H.R. (Undated). Hatchability Problem Analysis. University of Florida. Circular 1112.

APPENDIX 1
PREPARATION AND SAMPLE SELECTION

1. The following equipment will be required when investigating hatchery problems:

- Scales with which to weigh entire trays of eggs to the nearest 10g.
- Miniature temperature loggers capable of measuring temperature to an accuracy of 0.2ºC.
- Forceps.
- A table placed in good light, away from routine hatchery work.
- A plentiful supply of disposable Keyes trays.
- A large waterproof bin, to receive waste.
- Paper towels.
- Recording forms. (See attached examples).
- Disinfectant spray.
- Gloves.

2. Choose up to 4 farms for the investigation, approximately one week before the eggs are to be set and 28 days before the planned hatchery visit.

3. On each farm, place one or more miniature temperature loggers in a nest box after the last egg collection of the day.

4. On collection the following day, treat the miniature temperature loggers in the same way as the eggs from that collection. Pass them through any disinfection procedure, protected from water or chemical damage with plastic bags and tape as necessary. Place them in the trays with the hatching eggs before placing the trays in the egg store.

5. Mark the trays containing the miniature temperature loggers, so that they can be found at the hatchery.

6. At the hatchery, identify 8-10 trays of eggs per farm (i.e. 1000-1200 eggs in total). These should be of known and similar egg age; if possible they should be representative of the egg age current in the system. Include the trays containing the miniature temperature loggers in the sample.

7. Mark the trays clearly and weigh each tray. Record the weights on Form 1, (see attached). Check the weight of empty trays.

8. Distribute the sample trays evenly throughout the setter, (e.g. 1 top, 1 middle and 1 bottom tray at 3 points throughout the setter), so that incubator position effects can be identified.

9. Three or 4 days before the due hatch date, set one full tray of eggs from each farm for fertility assessment. These will all be opened and therefore will not be available for hatching.

10. At candling, do not remove any eggs from the sample trays unless they are rotten or leaking, in which case they should be recorded on Form 1. (See attached).

11. Re-weigh the trays at transfer, noting the date.

12. On the day of the hatch, count the chicks and culls on each tray, recording the numbers on Form 1. (See attached).

13. Save the dead-in-shell eggs, by tray, on labelled Keyes trays.

APPENDIX 2
IDENTIFICATION OF STAGES OF DEVELOPMENT AND ABNORMALITIES

STAGES OF DEVELOPMENT

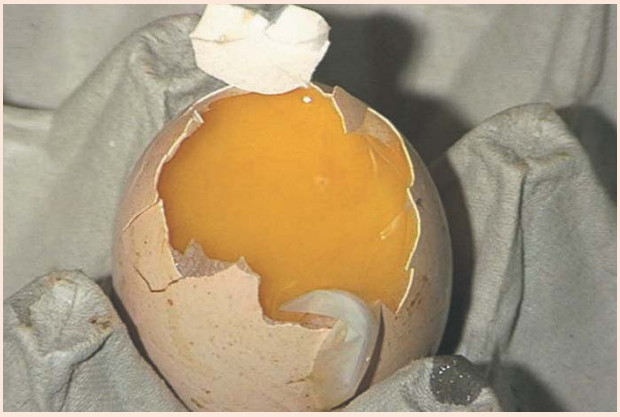
The appearances of chick embryos at different stages of development are well documented. However, an embryo which dies at 4 days of incubation, and which then remains in the incubator for a further 17 days, will be subject to considerable deterioration. The photographs show changes due to decay where embryos have died and the eggs have then spent the full 21 days in the incubators.

Every egg opened should be assessed for bacterial contamination, (i.e. egg contents green, black or associated with rotten odours). They should be recorded as 'early rot' if the embryo died at the 'black eye' stage or before, and 'late rot' if it had reached the 'feathers' stage or later. 'Early rots' will tend to be caused by contamination on the farm and 'late rots' by contamination within the hatchery.

The proportion of eggs with poor shell quality, holes and cracks should also be recorded at this stage. Eggs, which can be identified as having been set upside-down, should also be recorded.

Infertiles

FIGURE 18: INFERTILE EGG AFTER 21 DAYS OF INCUBATION

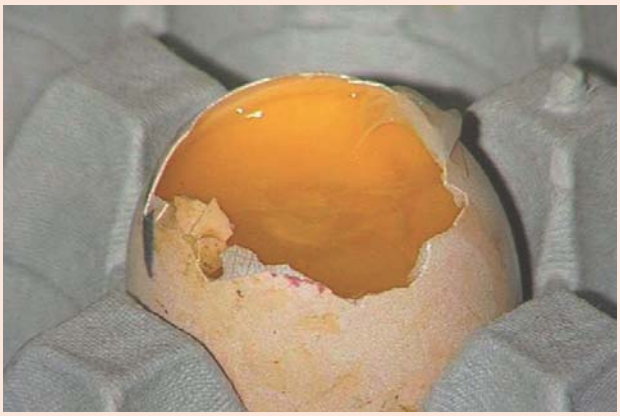


There is no visible embryonic growth, but sometimes a small, dense white dot can be seen which is the remains of the germinal disc. This will disappear during incubation in most eggs. The egg contents resemble those of an eating egg.

Possible Causes: Males not mating because they are overweight or have foot problems. Males losing condition due to insufficient feed. Mating ratio too high or too low. Females avoiding males because they are or have been too vigorous (i.e. overmating). Disease.

Early Dead Embryos - 24 hours or less

FIGURE 19: EMBRYO WHICH DIED AFTER ONE DAY OF INCUBATION



There is no obvious embryonic growth, but sometimes the remains of a blastoderm can be seen. The surface of the yolk is slightly disrupted. The contents do not resemble those of a fresh eating egg.

Early Dead Embryos - up to 48 hours

FIGURE 20: EMBRYO WHICH DIED AFTER 2 DAYS OF INCUBATION

A cream coloured membrane is evident on the surface of the yolk, of diameter between 5mm and 2cm. There are no blood vessels present.

Possible Causes: Eggs stored too long (i.e. >7 days), or stored in unsuitable conditions (i.e. too cold, too warm or of fluctuating temperature). Infrequent egg collection. Incorrect disinfection of eggs (e.g. at too high a temperature or fumigation in the first 12-96 hours of incubation). Early incubation temperature too high. Any problem prior to the start of incubation is likely to increase early mortality.

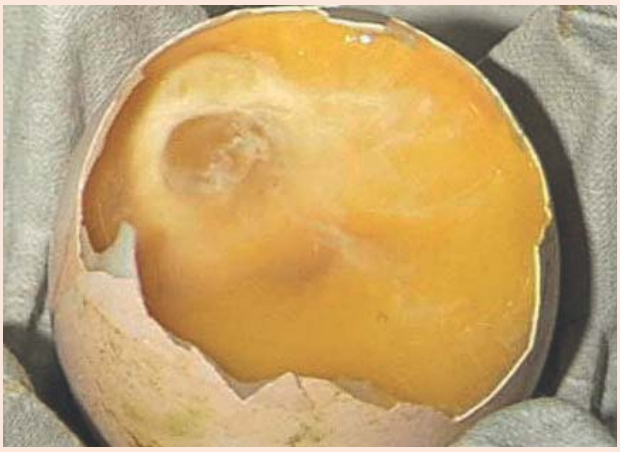
Stress experienced by the parent hens will cause mottling of the vitelline membrane covering the egg yolk. This may also cause elevated levels of early dead embryos. Stressors

include handling (e.g. for blood sampling), changes in routine and overmating. Figure 21 shows a partly incubated egg affected by pronounced mottling.

FIGURE 21: PARTLY INCUBATED EGG AFFECTED BY PRONOUNCED YOLK MOTTLING

Blood Ring
- Embryonic Death from 2.5 - 4 days

FIGURE 22: EMBRYO WHICH DIED AT APPROXIMATELY 3 DAYS



Cream coloured membrane growing over surface of yolk. Circulatory system has started to develop. Clear area in the centre of the egg caused by a fluid-filled sac may be the only evidence after 21 days of incubation.

Possible Causes: Same as for early dead embryos and also the possibility of bacterial contamination.

Black Eye
- Embryonic Death from 5 - 10 days

FIGURE 23: CONTAMINATED EGGS IN WHICH EMBRYOS DIED AFTER APPROXIMATELY 6 DAYS

The embryo will have developed an eye, which can be seen easily. Embryos that die at this stage are often grossly contaminated.

Possible Causes: Gross bacterial contamination caused by poor nest hygiene, inappropriate egg disinfection or condensation due to sudden variation in temperature during storage. Often associated with floor eggs, especially those which have been washed.

Feathers
- Embryonic Death from 11 - 17 days

FIGURE 24: VIEW OF EGG CONTENTS IN WHICH EMBRYO DIED AT APPROXIMATELY 16 DAYS

Feathers start to appear at about 11 days of incubation. Dead-in-shell embryos in this category do not quite fill the shell. The head tends to be in the pointed end of the shell. The egg contents are often the dark, reddish brown colour of dried blood.

Possible Causes: Most nutritional deficiencies will increase mortality at this stage, as will contamination. Inappropriate incubation conditions will also increase these mid-term deaths.

Turned
- Embryonic Deaths from 18 - 19 days
The embryo fills the egg and the head is in the blunt end of the shell. The yolk sac is still outside the abdomen. The chick should be examined for signs of developmental abnormalities, excessive moisture or an upside-down malposition.

Possible Causes: Inappropriate temperature or humidity in the setter or hatcher. Damage at transfer. Nutritional deficiencies or egg contamination will increase mortality at this stage. Turning problems i.e. frequency or angle of turning. Egg set upside-down. Excessive moisture in the egg will tend to be associated with low egg weight loss and will be due to high humidity or low airflow in setters and hatchers.

Pipped Air Cell
The embryo fills the shell, and the head is in the blunt end of the shell. The yolk sac is mostly or entirely inside the abdomen. Developmental abnormalities may be visible.

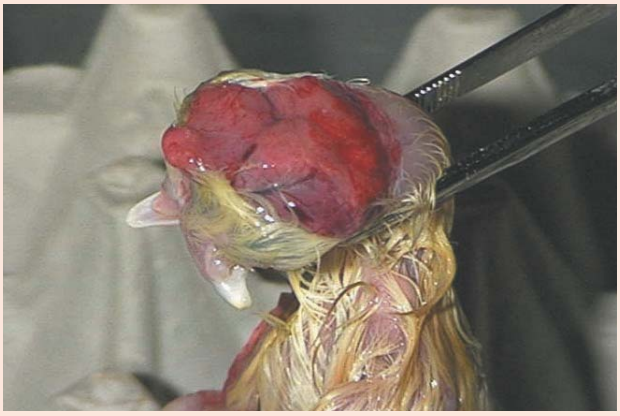
Possible Causes: Same as for turned eggs. Humidity too high.

Pipped Shell
Fully formed embryo has made a hole in the shell, but has not emerged. It may be alive or dead at the time of opening.

Possible Causes: Low humidity, high temperatures or inadequate ventilation in the hatcher. Inadequate turning or eggs set upside-down. Nutritional deficiencies or disease can also increase mortality at this stage, as can excessive egg storage time and transfer damage.

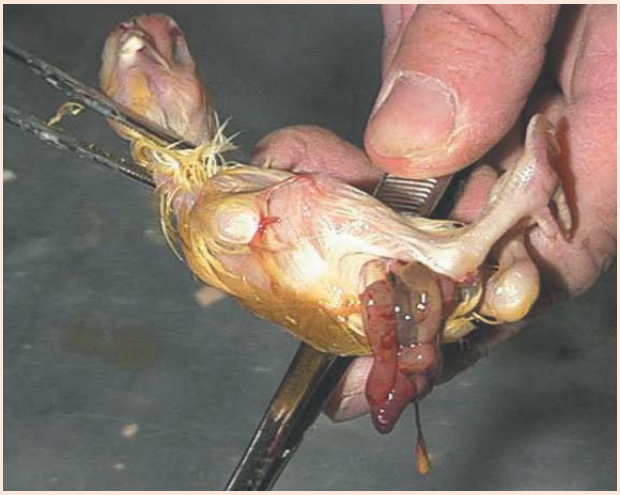
Developmental Abnormalities

FIGURE 25: EXPOSED BRAIN



This will have been caused by too high a temperature from 1-3 days of incubation. Too high a temperature up to Day 6 will cause failure of eye development.

FIGURE 26: ECTOPIC VISCERA



In this case, the intestines are outside the abdominal cavity of an otherwise fully developed chick. It is caused by excessively high setter temperatures mid-incubation.

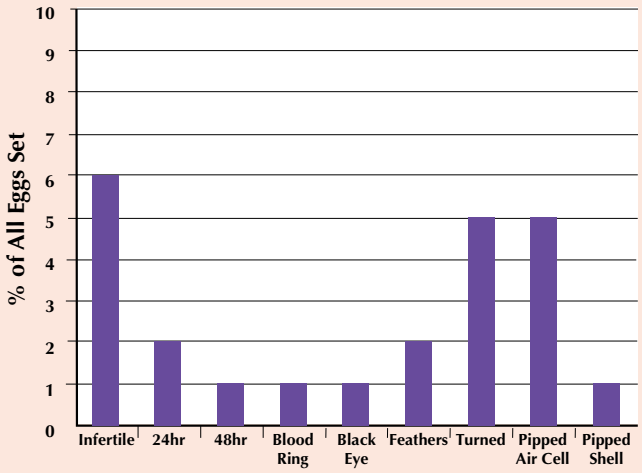
Embryo Upside-down
This is identified by the hocks of the 18-day+ embryo being visible immediately below the air cell. This may have been caused by the egg having been set upside-down or the angle of turning inside the setter machine may have been too small.

Vitamin and Mineral Deficiencies
Severe vitamin deficiencies are relatively unusual. They are extensively documented elsewhere and will not be described further here.

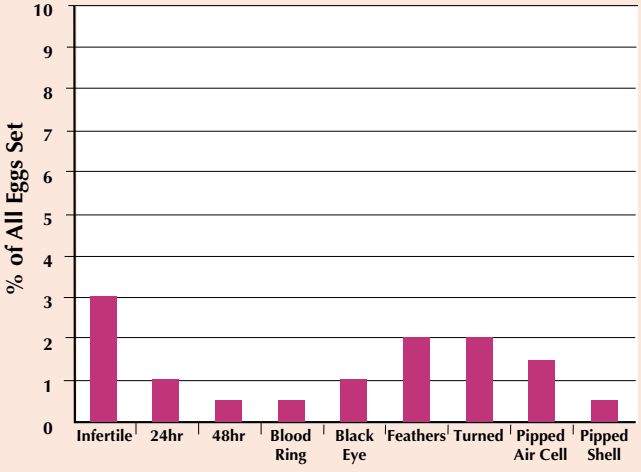
APPENDIX 3
TYPICAL EMBRYONIC MORTALITIES AT DIFFERENT FLOCK AGES

AGE OF PARENT STOCK	STAGE OF DEVELOPMENT OF EMBRYO									
	Infertile	24 hours	48 hours	Blood Ring	Black Eye	Feathers	Turned	Pipped Air Cell	Pipped Shell	Total
Young 25 - 30 weeks	6	2	1	1	1	2	5	5	1	24
Peak 31 - 45 weeks	3	1	0.5	0.5	1	1	2	1.5	0.5	11
Post Peak 46 - 50 weeks	4	1	0.5	0.5	1	1	2	1.5	0.5	12
Ageing 51 - 60 weeks	8	2	1	1	1	1	1.5	1	0.5	17

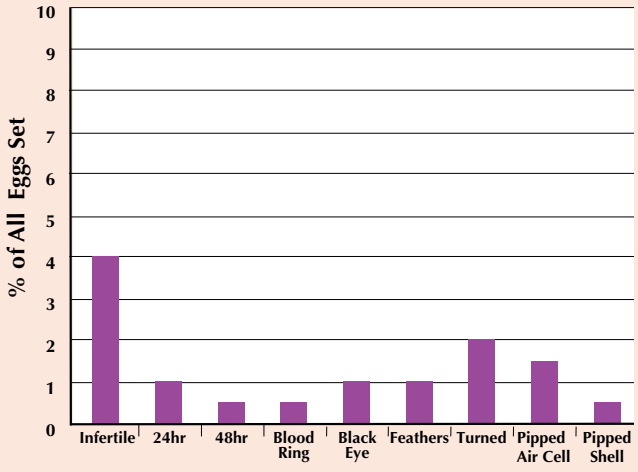
Typical Embryronic Mortality
- Parent Flock 25-30 Weeks



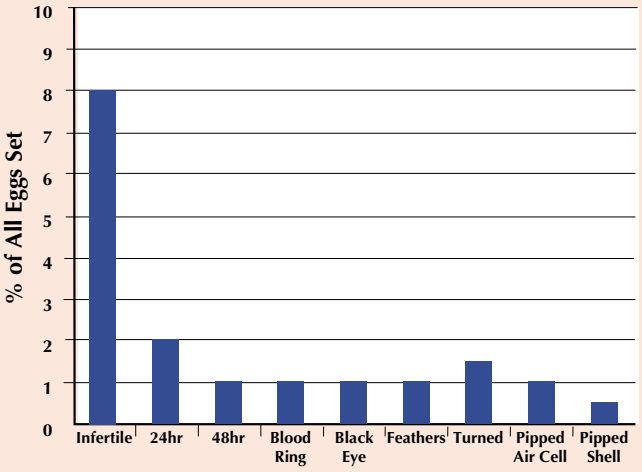
Typical Embryonic Mortality
- Parent Flock 31-45 Weeks



Typical Embryonic Mortality
- Parent Flock 46-50 Weeks



Typical Embryonic Mortality
- Parent Flock 51-60 Weeks



APPENDIX 4
HATCHERY RECORDING FORMS

ROSS

Form 1 Egg Weight During Incubation

Company.....

Farm..... Date set.....

Age..... Date hatched.....

Date broken out.....

Setter No..... Hatcher No.....

Tray	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
No of eggs										
Initial weight										
Transfer weight										
Chicks										
Culls & dead										
Unhatched Eggs										

Average empty tray weight.....

Farm..... Date set.....

Age..... Date hatched.....

Date broken out.....

Setter No..... Hatcher No.....

Tray	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
No of eggs										
Initial weight										
Transfer weight										
Chicks										
Culls & dead										
Unhatched Eggs										

APPENDIX 4
HATCHERY RECORDING FORMS (CONTINUED)

Form 2 Hatch Debris Analysis

Company..... Date set.....

Farm..... Date hatched.....

Age..... Date broken out.....

Setter No.....

Hatch tray size..... Hatcher No.....

Tray No	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*	*% of Eggs Set*
Eggs Clear												
Eggs DIS												
Infertile												
24h												
48h												
Blood Ring (2.5-4d)												
Black Eye (5-10d)												
Feathers (11-17d)												
Turned (18-19d)												
Pipped (air cell)												
Pipped Shell												
Dead and Cull Chicks												
Early Rot												
Late Rot												
Wet												
Brain/Eye												
Ectopic Viscera												
Embryo Upsidedown												
Shell Quality												
Cracked												
Set Upsidedown												
Other												

Form 3 Part-Incubated Eggs

Company.....

Date.....

Farm								
No of Eggs Sampled								
No of Days Incubated								
Live Embryos								
Dead Embryos								
Black Eye								
Blood Ring								
48 hours								
24 hours								
Infertile								

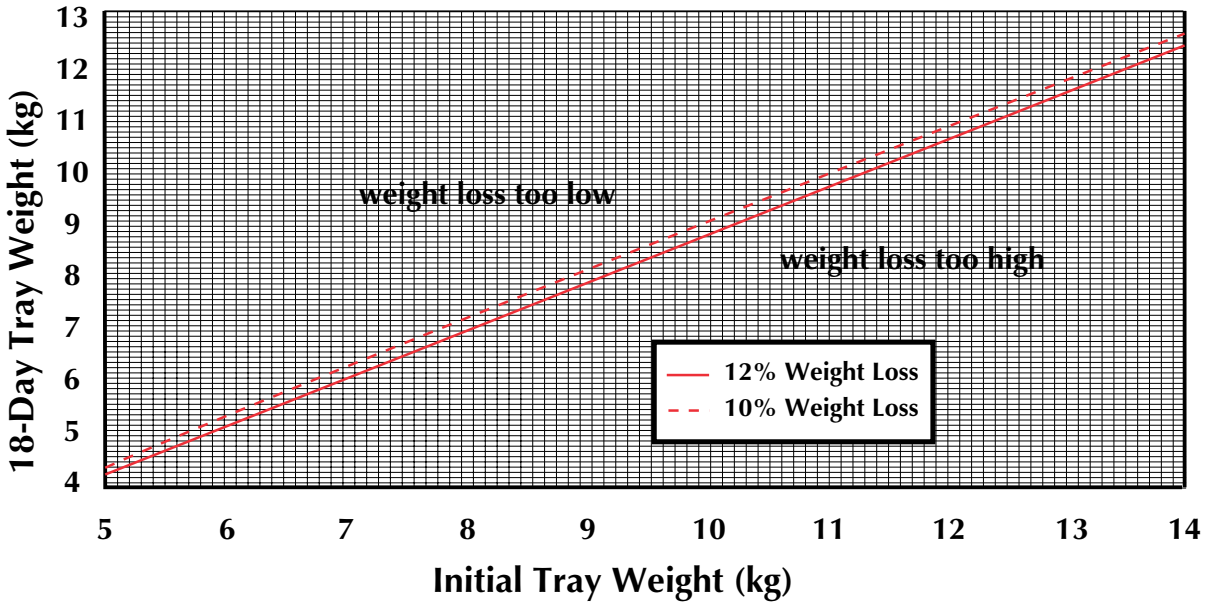
Form 4 Unincubated Eggs

Company.....

Date.....

Farm								
No of Eggs Sampled								
Fertile								
Infertile								
Mottled Yolk								
Watery Albumen								
Sticky Yolk								

Incubation Weight Loss target



This information comes to you from the Technical Team of Aviagen. Although it is considered to be the best information available at the present time, the effect of using it cannot be guaranteed because performance can be affected substantially by many factors including flock management, health status, climatic conditions etc.
Every attempt has been made to ensure the accuracy and relevance of the information presented. However, Aviagen accepts no liability for the consequencies of using the information for the management of chickens. Data presented in this Ross Tech should not therefore be regarded as specifications but illustrate potential performance.

For further information on the range of technical literature available for Aviagen Stock please ask your local Technical Services Manager or contact our Marketing Department at:

Aviagen Limited
Newbridge
Midlothian
EH28 8SZ
Scotland
UK

tel: +44 (0) 131 333 1056
fax: +44 (0) 131 333 3296
email infoworldwide@aviagen.com

Aviagen Incorporated
5015 Bradford Drive
Huntsville Alabama 35805
USA

tel +1 256 890 3800
fax: +1 256 890 3919
email info@aviagen.com

website www.aviagen.com

JULY '03

Aviagen™