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EMBRYO DIAGNOSIS
AN IMPORTANT TOOL TO HELP THE HATCHERY MANAGER

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INTRODUCTION

Chick quality is the first criterion for assessing a hatchery's quality of work, and is determined by distinguishing between marketable and unmarketable chicks. When necessary, a quality score can be determined using specific assessment charts. Although rarely routinely done, unhatched eggs may also be checked. Embryo diagnosis is a technique which consists in opening unhatched eggs to determine the moment embryonic development stopped and, if possible, identify the cause.

Whatever the results from these assessments, it should be remembered that they include factors that are entirely controlled by the hatchery, namely the breeders' statuses and the on-farm sorting strictness. This is why it is important to regularly check eggs coming from each of the breeder flocks so as to prepare incubation correctly, ensure performance traceability, but also identify external dysfunction causes as early as possible.

Weekly records should be communicated to farmers along with their comparison to the hatchery's mean and their evolution. The objectivity of the results makes it possible to initiate a constructive debate between the hatchery manager and the production manager.

EMBRYO-DIAGNOSIS

The embryo-diagnosis is the diagnosis of embryonic mortality. It can be basic or detailed depending on the problems encountered and the objectives to be reached.

1. Diagnosis Approach

Examination of embryos in unhatched eggs is the first step. It allows a general view of embryonic mortality as all the embryos which have died since the beginning of incubation–except those culled at candling at 18 days–are being examined at that time.
It is valuable to have the data from candling to transfer at one's disposal, in order to know whether embryonic mortality occurred before or after (or even at the time of) transfer.
If mortality occurred prior to transfer, a few eggs will then have to be examined in the early period of incubation in order to differentiate early embryonic mortality from true infertility.

a. Opening of Unhatched Eggs

At chick hatching, unhatched eggs will be examined to determine the reason for failing to hatch. All unhatched eggs will be opened on one or two trays per batch minimum, and at best, on 4 to 5 trolleys uniformly distributed in the hatcher. This represents approximately 1 hour work for 100 eggs. It is useful to perform this examination once a week, routinely, so as to detect/interpret abnormalities more rapidly and obtain comparative data.

After identifying the origin of each tray, all the remaining eggs will be broken and classified according to embryonic development stage.

During egg examination, the main parameters to be examined are:
- ☑ egg size and egg shell quality
- ☑ air cell
- ☑ age of developing embryo
- ☑ embryo position (standard: beak under right wing, legs brought up toward the head) and embryo anatomy.

The embryo is particularly fragile during the first week of incubation, the period when organs differentiate; problems consist of early embryonic mortality or malformations. To a lesser extent, mortality can also occur in the late incubation period (18-19 days)–due to respiratory failure, poor resorption of the yolk vesicle–or at hatching (called pipped unhatched chicks).

b. Early Embryonic Mortality vs True Infertility: Examination of Eggs at the Beginning of Incubation
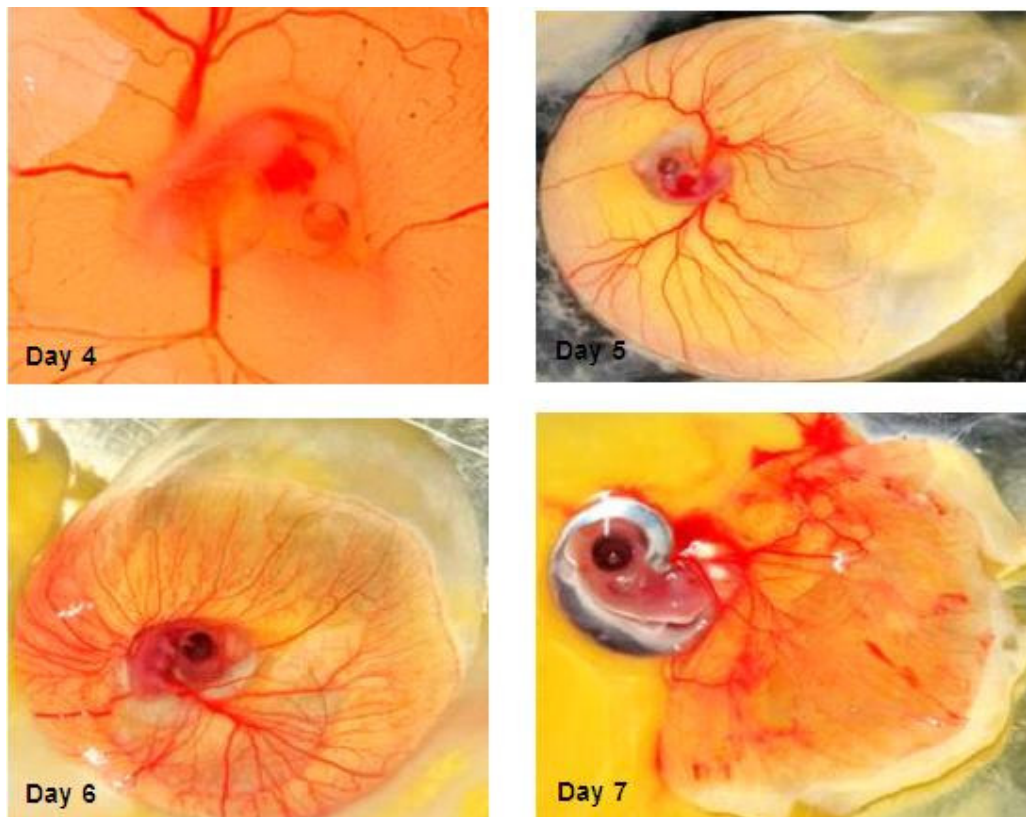
Distinguishing early embryonic mortality from true infertility is very difficult to perform on unhatched eggs. After 21 days of incubation, only the presence of embryonic annexes and the severe deterioration of the internal structures of embryonated eggs allow the latter to be distinguished from unfertilized eggs, which have remained in a better state.

Candling at the time of transfer makes it possible to orient the diagnosis toward early or late mortality. Similarly, thorough (manual) candling around 8-10 days of incubation, makes it possible to evaluate early embryonic mortality: this is the percentage of embryos that died in the initial stage of incubation, just after the mortality peak of the first days.

However, among the other eggs, which are clear eggs, candling does not enable true infertile eggs–still at the ovum stage–to be distinguished from fertile eggs whose embryos have not resumed development when set for incubation. This is why, when eggs are set for incubation, it is more correct to speak of non-clear eggs rather than fertile eggs, although this term is often used.

In order to make the distinction, the only method–obviously costly and therefore exceptional–consists in breaking 400 to 500 eggs at 4-5 days of incubation and examining the presence and appearance of the embryonic disc.

Picture 1: Hatching Egg at D4, D5, D6 and D7

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2. Presentation of Results – Main criteria

When adding up the different numbers recorded, four ratios should be retained: "fertility", early embryonic mortality, number of chicks hatched from fertile eggs and total hatchability.

- ☑ "Fertility" = Number of "fertile"* eggs at setting/number of incubated eggs
- ☑ Early embryonic mortality = Number of dead embryos at 10 days of incubation/number of incubated eggs
- ☑ Hatchability on fertile eggs = Number of hatched chicks (including the dying ones culled on the sorting belt)/number of "fertile"* eggs
- ☑ Total hatchability = Number of hatched chicks/Number of incubated eggs.

* As mentioned above, the eggs said "fertile" are in fact eggs that are non-clear when candled at 10 days.

The following tables give indicative values of performance levels. Fertility and then total hatchability are not reported in these standard values as they vary greatly with age and strains.

Table 1: Indicative Performance Records

Assessment	Early embryonic mortality	Hatchability from fertile eggs
Excellent	< 2%	> 93%
Very good	< 3%	> 90%
Good	< 5%	> 87%
Average	< 8%	> 83%
Poor	> 8%	< 83%

Also, for information, pipped unhatched chicks must be < 1.5% and culled chicks < 1%. It should be noted that a hatchery may be scored well for a criterion and poorly for another.

Table 2: Example of Performance Control Until Hatching

Incubation Tray No	Eggs/ Tray	Clear eggs	Mortality 1-10 d	Mortality 10-18 d	Mortality 18-21 d	Pipped unhatched	Culled chicks
No 1	150	2	4	3	1	2	1
No 6	150	4	5	4	1	1	0
No 11	150	2	3	5	1	1	2
No 16	150	3	4	3	2	2	1
Total	600	11	16	15	5	6	4
%	100%	1.8%	2.7%	2.5%	0.8%	1.0%	0.7%

Number of "fertile" eggs	600-11	589
Total mortality	11+16+15+5+6+4	57
Number of chicks	600-57	543

% "Fertility"	589/600	98.2%
% Early mortality	16/600	2.7%
% Hatchability/fertiles eggs	543/589	92.2%
% Total hatchability	543/600	90.5%

3. Non-hatching Causes

The following table presents all the possible causes of a drop in hatchability. In order to organize the potential problems according to their importance, three major sources of embryonic mortality must be cited:

Egg hygiene: The hatchability of a batch is often directly correlated with the number of floor eggs, whose hatchability level is regularly lower by 10% to 15% compared to clean eggs.

Egg handling: It is often forgotten that the egg contains an extremely fragile organism; conveyor system and transfer automation can improve hatchability by up to 2%.

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Storage and incubation parameters: temperature, relative humidity and ventilation; hyper- or hypothermia in particular result in embryonic malformations:
- ☑ Hyperthermia, with ocular, cardiac or renal lesions (following circulatory problems),
- ☑ Hypothermia, with disharmonious development of the different organs.

Table 3: Non-hatching Causes

TRUE INFERTILITY -> PROBLEM ON THE FARM			
Roosters	Sterility or unsuitable age of roosters (too young, too old) / Or insemination problem Excessive weight gain or weight loss incorrect % of roosters		
Hens	Excessive density Broodiness		
Both sexes	Nutritional deficiency Lameness, parasitism or other pathology Thermal stress or treatment causing a drop in consumption Intoxication (nicarbazine) Aggressive behaviors (mostly concerns roosters) Building design impeding treading		
EMBRYONIC MORTALITY -> PROBLEM ON THE FARM OR AT THE HATCHERY			
	Farm	**Storage**	**Incubation**	**Transfer / Hatching**
Early mortality	Contaminated eggs Pre-incubation Cracked eggs (age of breeders) Infectious disease Nutritional deficiency	Cooled or overheated eggs Too long Washing with too warm water Lack of O2, excess of CO2	Excessive fumigation Too low T and too high RH Incorrect egg turning	
Late mortality	Contaminated eggs Infectious disease Nutritional deficiency	Too long	Too high T and too low RH Too low T and too high RH Incorrect egg turning	Poor ventilation T and RH too high
Pipped, unhatched	Genetic problem Infectious disease Nutritional deficiency	Too long	Eggs small end up Incorrect egg turning Insufficient ventilation Too low T and too high RH	Trauma during transfer Late transfer Excessive fumigation
Malformations Incorrect positions	Genetic or infection (crossed beak) Nutrition (twisted neck, crooked fingers) Misshapen eggs		T variations (absence of eyes) Handling during 1st week Eggs small end up Incorrect egg turning	
Broken eggs	Rough handling Age of breeders Nutritional or infectious problem, thermal stress	Rough handling	Rough handling	Rough handling
Contaminated eggs	Poor egg shell quality Too infrequent egg collection Poor nest hygiene	Condensation on eggs Insufficient decontamination	Incubation of dirty eggs	
Culled chicks	Small eggs (early hatching) Large eggs (late hatching)	Too long: late hatching, omphalitis problems	High T: early hatching, omphalitis problems Low T or RH: late hatching Incorrect egg turning	Low T: late hatching High RH: weak chicks, Omphalitis problems

(T: temperature, RH: relative humidity)

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The following graphic illustrates the major causes for hatching failures under normal circumstances, in Gallus specie.

Graphic 1: Respective weight of non-hatching causes under normal conditions, in Gallus specie
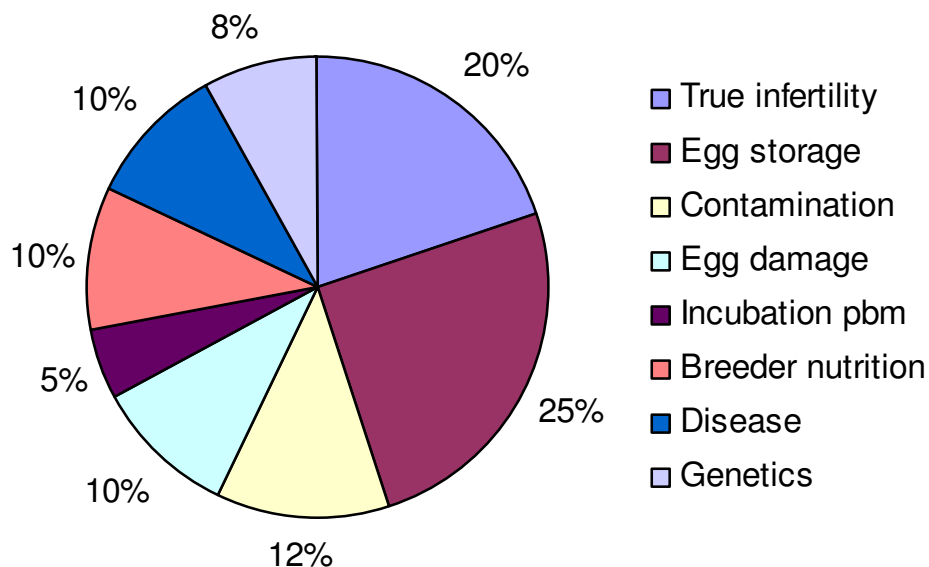
Source: Poultry Diseases, 5th Ed.

CONCLUSION

Without a doubt, incubation is a rather complex matter. Nevertheless, any abnormal result can be explained by an in-depth analysis of the various parameters, particularly by "opening" the eggs set for incubation. Therefore, each technician or hatchery manager should clearly understand that he/she must implement regular performance monitoring in his/her organization or service in order to improve results, as well as to prevent mishaps or rapidly identify their causes.

This monitoring activity may require the hiring of an employee specifically trained to this type of work; however, one should be aware that the investment return will be substantial: 1% improvement of total hatchability can represent considerable profits even in medium-sized structures.

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