Incubating Waterfowl

Simplified Beginner's Checklist

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- [ ] As much as possible, encourage ducks and geese to lay in clean dry nests. Once they begin to lay in an ideal location, keep 4-5 fake, ceramic eggs in the nest to keep them laying there.
- [ ] Identify the time of day when eggs are laid and collect as soon as possible. The longer the eggs sit in a dirty nest, the greater the chances of bacterial contamination.
- [ ] Wash hands and use only a clean, sanitized containers for collection. Touching contaminated surfaces and then touching hatching eggs will transfer the contaminates to the eggs.
- [ ] When necessary, rinse and sanitize eggs coated in dirt/mud immediately after collection. Oxygen exchange and water loss is impaired in coated eggs leading to early death or weakened hatchlings.
- [ ] Store eggs in a clean, closed container in a cool, humid location. Waterfowl eggs do not store as well as chicken eggs and should be set within 7 days of collection. Turning eggs in storage is optional.
- [ ] Prewarm cool eggs to room temperature prior to setting to avoid condensation (water drops) on egg shells and to assist in bringing the incubator up to temperature in a timely manner.
- [ ] Calibrate a separate thermometer and hygrometer to verify incubator readings. Measure temperature at mid-egg level. Never trust the incubator gauges until they have proven accurate.
- [ ] Set incubation temperature at 99.5-99.8°F (37.5-37.7°C). Check for warm and cool spots within the incubator and rotate eggs daily as necessary. Waterfowl eggs do not do well at cooler temperatures.
- [ ] Do not turn the eggs for the first 24 hours after setting. The tiny embryo is in a very fragile state as the egg warms and any sudden or sharp movement can disrupt cell adhesion leading to early death.
- [ ] Waterfowl eggs should be tilted hourly by at least 40° from center. Extra-large eggs should be set on their side in tilt trays and provided an extra, manual 180° turn daily. Hand turning five times a day is preferrable to using desktop auto-turners that cannot turn eggs on an hourly basis.
- [ ] Hobbyist may be tempted to squeeze in as many eggs as possible into the incubator but crowding decreases air flow around the egg and impedes oxygen exchange and the necessary loss of water.
- [ ] Starting on Day 7, mist eggs with room temperature water. Misting helps degrade the thick, waxy cuticle (bloom) allowing for an exchange of oxygen and carbon dioxide in support of metabolism.
- [ ] By Day 10, begin a daily regime of cooling large eggs. As the embryo develops, metabolism generates heat from inside the egg and can lead to excess heat build-up in larger eggs.
- [ ] At hatch-time, stop turning eggs, place them on their side, open all ventilation ports, increase humidity to +60%, and lower temperature by 0.5-1.0°F.
- [ ] Do not open the hatcher while eggs are pipping, zipping, or hatching. Realize that hatchlings can live without food or water for 36-48 hours after hatch.
- [ ] Be patient at hatch-time, ducklings and goslings take a long time to hatch. Assisting hatchlings to hatch generally results in doing more harm than good.
- [ ] If high humidity becomes a concern during hatch-time >85%, momentarily crack the lid. Do not permit the temperature to drop inside the hatcher.
- [ ] Take the time to evaluate hatches, attempt to figure out why some eggs failed to develop or hatch, and alternative methods may improve hatch results.
- [ ] Clean and sanitize the hatcher thoroughly after each hatch.

Incubating Waterfowl

Maximizing Hatch Rate and Hatchling Quality

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INTRODUCTION

Hobbyists looking for a single, magical incubation protocol for duck and goose eggs will be disappointed… there simply isn't one. There are too many variations in egg size, cuticle thickness, shell characteristics, and seasonal variations. This paper explores the traits of waterfowl eggs, various methods for dealing with those traits, and provides a model protocol that works well in my specific working environment. For best results, individuals should apply different techniques until they discover what works best for them.

MY INITIAL EXPERIENCE

My first two batches of domesticated mallard eggs were disasters. Only two of 30 eggs hatched in the first batch, and only one of 30 in the second. My mallard hens, on the other hand, seemed to achieve a hatch rate of 100%. However, upon closer observation, I discovered than my ducks were cheating… they would roll out their bad eggs for my turkeys to eat. When I started counting the number of eggs at the start and compare with the number of healthy ducklings, I learned that they achieved only about a 76% hatch rate. Their method wasn't perfect either.

Determined to do better, I set out to research incubating duck eggs and discovered four major flaws in my technique:

1. My desktop turner was inadequate for incubating duck eggs.
2. Slightly lower temperatures can ruin a batch.
3. Bacteria plays a significant role in achieving high hatch rates.
4. Misting and cooling improves the oxygen permeation, water loss, and shell brittleness.

On the third batch of duck eggs, I achieved a hatch rate of 86% of all eggs set and 94% on the fourth… a better rate than my broody ducks.

If it ain't broke, don't fix it.
If it is broke, take the steps necessary to fix it.

EGG DIFFERENCES

- **LONGER INCUBATION PERIODS**: Waterfowl eggs require a week or more incubation than standard chickens.[1] Small errors, such as slightly low temperatures, may not have a significant impact on hatching chickens; however, extending those errors an additional week can turn minor problems into major ones.

Standard Chicken – 21 days	*Domestic Duck – 28 days*	*Domestic Goose – 30 days*
Mallard Duck – 26.5 days	*Muscovy Ducks – 35 days*	*Swan – 35 days*

- **THICKER CUTICLES (BLOOM)**: Waterfowl often lay their eggs in wet locations teaming with bacteria, fungi, and mold. To combat these potential deadly problems, waterfowl eggs have a thick waxy cuticle that reduces penetration of the shell.[2] In nature, nesting activities naturally erode the cuticle during the first week; unfortunately, such mechanical processes are absent in artificial incubation and these thicker coatings inhibit internal water loss and the exchange of gases.

  In duck incubation, the most common challenge is the high number of so-called 'drowned' or 'wet-embryos'. These embryos die during the fourth week of incubation as a result of insufficient water evaporation from the eggs.[3]

Low porosity eggshells restrict diffusion of oxygen into the egg, which retards embryonic growth and eventually kills the embryos (and is not restricted to duck eggs).[4]

In Nature, the cuticle is naturally degraded by friction from nesting activities[5] *and erosion from surface bacteria during the first week of incubation.*[6] *Unfortunately, both of these factors are absent within the incubation environment and artificial measure are required.*

- **THICKER & HARDER SHELLS**: As an added protection against contaminant, waterfowl eggs have thicker, denser shells. [7] In nature, nesting activities change these shell characteristics; unfortunately, such mechanisms are absent in artificial incubation and thicker shells can pose difficulty with pipping and zipping during hatch-time.

  In artificial incubation, the cooling of waterfowl eggs (by spraying water on the surfaces of the eggs) is important as it will soften the membrane under the shell and make the shell crisp which makes it easier for the piping process before hatching.[8]

- **LARGER EGGS**: Geese and most ducks lay larger eggs than standard chicken eggs. Large eggs absorb and release heat much more slowly than smaller eggs resulting in excess heat buildup as the embryo generates more and more internal, metabolic heat. In nature, broody hens instinctively relieve this heat build-up by either lowering nest temperature or by leaving the nest more frequently and for longer periods; unfortunately, such mechanisms are often absent in artificial incubation

  During incubation, all female waterfowl take breaks… On average, females leave the nest three times per day, and each recess lasts about an hour.[9]

  The cooling is particularly important from day 15 of incubation when the embryo starts to produce heat due to its metabolism, thus the temperature of the egg is continuously higher than the temperature inside the incubator.[10]

REPLICATING MOTHER NATURE

Backyard hobbyists typically believe that replicating the natural incubation conditions as closely as possible provides positive results. However, in reality, there are vast differences between natural and artificial incubation:

- **TURNING**: A broody hen will rotate her eggs as often as four time per hour, that's up to 96 times per day.[11,12] Artificial incubators generally strive to tilt eggs vertically 90° up to 24 times per day.
- **HEATING**: A broody hen will heat her eggs through conduction (touch) often removing a patch of feathers on her underside to make skin-to-egg contact. Conduction involves a minimum of air flow across the eggs. Artificial incubators heat eggs through convection (air). Convection relies on air movement and results in a drying effect on the egg shell. Humidity, therefore, becomes an important component in artificial incubation.
- **TEMPERATURE CONSISTENCY**: A hen raises and lowers nest temperature by building up her nest, standing up, or leaving the nest depending on the needs of the developing embryo. In artificial incubation, the air temperature is often held constant throughout the entire incubation process including hatch-time.

- **PERIODIC COOLING**: A broody hen will periodically leave her nest and allow the eggs to cool. The frequency and length of these breaks will depend upon the species and prevailing weather conditions. In artificial incubation, most hobbyists attempt to sharply limit breaks in the target incubation temperature… they try not to open the incubator unless absolutely necessary.

- **BACTERIA**: In Nature, bacteria (Bacillus Licheniformis) in the nesting site works to partially remove the cuticle in the first week of incubation.[13] In artificial incubation, great effort is made to eliminate the effects of bacteria in the incubation process.
- **INSTINCT**: A broody hen incubates her eggs through instinct; humans incubate through science.
- **HATCH RATES**: Broody hens do a pretty good job of hatching their eggs; however, artificial incubation is better able to minimize negative environmental factors – such as weather, contamination, and predation. Generally, we can expect, if done correctly, higher hatch rates under artificial conditions than under a broody hen.

DISCUSSION

While it is unlikely that humans will ever be capable of incubating through instinct, there are some steps that we can take to better replicate Mother Nature and provide for the needs of our eggs.

1. **TURNING**: Most desktop automatic turners provide inadequate turning for poultry eggs, especially waterfowl. In some instances, a desktop may only turn the eggs 60° every four hours where the optimal for vertical turning is 90° every 30-60 minutes, especially for the first seven days.[1415] To compensate, many hobbyists incubate their eggs on their side in the automatic turner and provide an additional 180° turn daily. If your desktop does not provide vigorous turning, then you may want to consider turning by hand five times per day.

   SIGNS OF INADEQUATE TURNING: malpositioning, premature death, slow or incomplete development, failure to hatch, and malformations.

2. **WATER LOSS & GAS EXCHANGE**: Eggs need to lose approximate 11.5% of their total weight by hatch-time.[16] Much of this loss comes in the form of water loss. With chickens, humidity is the primary factor that controls this loss. However, with waterfowl, cuticle and shell thickness also plays a significant role.

   In commercial operations, hatcheries frequently wash waterfowl eggs in a hypochlorite (bleach) solution to completely remove the cuticle. Unfortunately, washing eggs and removing the cuticle is frowned upon within the hobbyist community because it dramatically increases the instances of contaminant shell penetration and related issues.

   Within the hobbyist environment, a routine of misting and cooling waterfowl eggs disturbs the integrity of the cuticle and shell porous surface resulting greater weight loss and gas exchange. Ultimately, including such a routine in one's incubation protocol could improve hatchability by as much as 20%.[17,18]

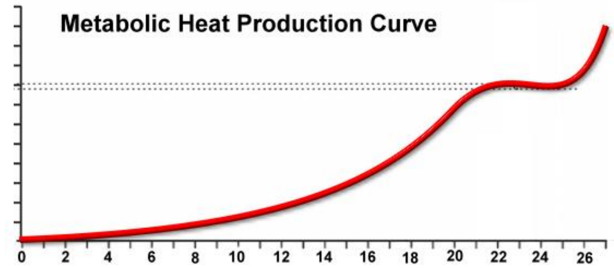
   SIGNS OF INADEQUATE WATER LOSS/OXYGEN EXCHANGE: premature death; underdeveloped embryos; late hatches; malpositioning; failure to pip internally, externally, or zip, small air cell; hatchling smeared with albumin; or "drowned," wet, smelly or mushy hatchlings.

   > *When gas exchange is not sufficient, hatchability is normally reduced by embryonic mortality in the second half of the incubation process. Most of the dead embryos are small but fully developed, and surrounded by a lot of fluid as a result of too less weight loss and a shortage of oxygen.*[19]

3. **SHELL CHARACTERISTICS**: Guinea eggs are thick and hard, and I always find it fascinating that keets are capable of pipping and zipping those shell… but they do. One would think that ducks and geese are well suited for their shells as well… and they generally do. Under artificial incubation, I have found that routine cooling and misting tends to make the shell more brittle. I theorize that the shell contracts when it is cooled and expands when it is reheated creating micro-fractures in the egg shell. This brittleness makes it easier for the hatchling to pip and zip the shell. While not generally considered a major benefit of a misting and cooling routine, it does make it easier on the hatchling.

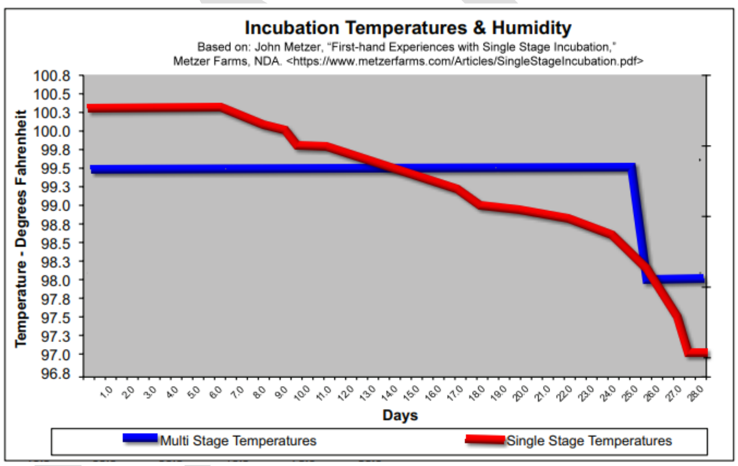
4. **TEMPERATURE**: Most hobbyists attempt to maintain one, consistent temperature inside the incubator from beginning to end – 99.5°F (37.5°C). This is often considered an imperative (crucial). However, this single setting is not considered ideal (perfect). During the beginning of incubation, a developing embryo generates very little heat through metabolism and depends upon external heat to maintain an ideal temperature of ~100.5°F (38°C). As development proceeds, the amount of heat generated through metabolism increases and the less external heat is required.

When the air temperature is too high, excess heat generated through metabolism may not efficiently escape the egg causing a heat buildup, especially in larger eggs. This heat buildup can result in heat stress, disrupt metabolic processes, and dramatically reduce hatch rates.[20]



Commercial hatcheries deal with the potential heat in two basic ways. First, some vary the air temperature with higher temperatures (100.5°F) at the beginning and lower temperatures (97.0°F) at hatch time. Lowering the temperature in the latter part of incubation allows heat to escape the egg and helps alleviate heat buildup. John Metzer, Metzer Farms, illustrates these air temperature variations used in single stage incubation:[21]

> ***SINGLE-STAGE INCUBATION****: Single-stage incubation (SS) can be defined as the process of incubating eggs of a single age in an incubator (all-in; all-out), while in multi-stage incubation (MS) eggs are typically placed into incubators at three-day intervals, resulting in incubation of multi-age embryos.*[22]



Second, some employ a system of periodic cooling eggs where egg shells are permitted to cool to about 86°F (30°C). This is accomplished either by removing the setting trays from the incubator or through automated cooling settings in single stage incubators. Because heat generated through metabolism dramatically increases towards the latter half of incubation, eggs are often cooled for 20 minutes twice a day after Day 16.[23]

SIGNS OF EXCESS HEAT BUILDUP: Premature death especially after Day 15, full-term embryos that fail to hatch, and hatchlings that fail to thrive in the brooder.

5. **SEASONAL VARIATIONS**: Not all eggs are created equally. Eggs from younger hens laid early in the season tend to have thicker cuticles/shells than those laid by older hens late in the season. Experiments conducted with Pekin duck eggs at the University of Guelpb, found that a routine misting of duck eggs resulting in an improved hatch rate as much as 26.8% in early season eggs but such advantage disappeared in late season eggs.[24] Such findings are consistent with similar findings here in East Texas on Roberts Farm. A routine of misting and cooling mallard duck and Chinese goose eggs seems essential in February – April, but misting and cooling demands higher humidity levels in

May – July to prevent excess water loss. In fact, during the months of June and July, I no longer cool or mist waterfowl eggs and encounter no noticeable ill effects.

Seasonal climate conditions also have a dramatic effect on the hatchability of waterfowl eggs.[25] Here in East Texas, the highest hatch rates for Chinese geese occurs with eggs laid early in the season (February-March). During these months, ground bacteria is at its minimal following freezing temperatures in December and January. As the weather warms and precipitation increases, ground bacterial counts surge and cuticle thickness declines leading to greater problems with bacteria. Depending on the specific Spring weather and where the geese lay their eggs, hatch rates can decline to near zero during the month of July.

6. **DIRTY EGGS**: Chickens generally lay their eggs in nice, clean nesting boxes that are easily sanitized. My waterfowl, unfortunately, tend to focus more on hiding their nests from predators than sanitation… they also cover their nests with dirt, leaves, and pine needles. While thicker cuticles and shells help prevent contamination penetration, eggs coated with dirt or mud will not be able to breath leading to problems with water loss and reduce gas exchange. Such problems must be addressed prior to setting eggs.

> ***GETTING DUCKS TO LAY IN THE SAME SPOT**: My mallard ducks do not like me stealing their eggs and move nesting sites if I remove their eggs. Since they can fly, finding their new nest may be difficult or impossible. Replacing their eggs with ceramic eggs keeps them laying in the same spot. They cannot count so as long as I keep five or six eggs in the nest, they'll not move.*

Many commercial hatcheries routinely wash eggs with a hypochlorite (bleach) solution. This eliminates the problem dirt, mud, bacteria, and a thicker cuticle. As discussed earlier, hobbyists are reluctant to wash eggs; however, not doing anything is not much of an option if the egg is coated with a large amount of dirt or mud. The following is the procedure that I commonly use:

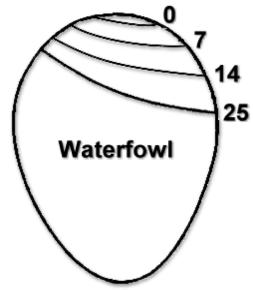
1. Run the hot water in the sink allowing the water to warm to about 110°F.
2. Place the egg in the water stream until all surfaces become wet then remove.
3. Allow the egg to set for a couple of moments. The idea is to permit just enough time for the water to penetrate and soften the dirt/mud.
4. Place the egg back under the water stream and gently rub the egg with a thumb being sure not to rub any single area more than twice.
5. Place the egg in a setting tray to allow the egg to dry completely.
6. Spray the egg with a sanitizing solution. (I prefer a warm Tek-Trol solution.)
7. Place the egg in a setting tray to allow the egg to dry completely.
8. Loosely cover the eggs with paper towel and store in a new or sanitized container.

SIGNS OF BACTERIA, MOLD, AND FUNGAL CONTAMINATION: eggs candle clear, blood ring (early death), premature death, slow or retarded development, dwarf hatchlings, unusual odor, oozing shells, exploders, full-term embryos that fail to hatch, wet/mushy hatchlings, hatchlings coated in purulent drainage, short/wiry down, weak hatchlings, and poor brooder performance.

> ***SANITIZING HATCHING EGGS**: There are several myths floating around the hobbyist community concerning sanitizing hatching eggs. In most cases, it is best to not disturb the cuticle; however, there are techniques that sanitize hatching eggs while minimizing the risk of damaging the cuticle. See my paper on sanitizing eggs at https://robertsfarm.us/pdf/Sanitizing_eggs.pdf.*

7. **CARBON DIOXIDE**: Within commercial operations using single stage incubation, higher levels of carbon dioxide during the initial phase of incubation results in increased hatchability and better performance after hatch. Increased levels of CO_2 apparently promote organ and vascular development, reduces thinning of the albumen (egg whites), and may contribute to shell thinning.[26,27] Monitoring CO_2 levels can be complex and require expensive instrumentation; however, within a hobbyist setting, simply keeping the ventilation ports closed during the first seven days of incubation can achieve a similar effect.

8. **HUMIDITY**: Among all the incubation settings, humidity probably causes the most concern because there is no single, agreed upon level. Even among the "experts" the ideal incubation level can vary from as high as 70% (Cornell U.) to as low as 57% (Metzer Farms). Personally, I find these levels much too high and speculate that washing eggs and cuticle removal accounts for the difference between what I find suitable (43-58%) and their recommendations.



What is a person to do? Experiment! I'd recommend starting off with the same level that I use (43-48%), evaluate the progress of the air cell as incubation progresses, evaluate the conditions upon hatch, then adjust up or down according to what you discover.

Humidity Too High	Humidity Too Low
small air cell	large air cell
hatches late	hatches early
large hatchlings	small hatchlings
wet hatchlings	dry hatchlings
hatchling fails to zip	shell fragments stuck on hatchling
hatchling fails to fluff	glue like substance present

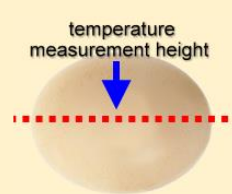
METHODS:

- **EGG SHELL TEMPERATURE**: As a general rule during cooling, the egg shell should cool to 86°F (30°C) as measured by an infrared thermometer. If no IR thermometer is available, then placing an egg against your eyelid will work. If the egg feels warm, more cooling is indicated. If the egg feels neutral, then the cooling has been sufficient. If the egg feels cool, then too much cooling has occurred.[28]

- **CALIBRATE INSTRUMENTS**: The #1 error when incubating any form of poultry is failure to calibrate the thermometer and hygrometer. While chickens may hatch under less than perfect temperatures, ducks and geese do not. Slightly low or high temperatures have a negative impact on metabolic rates and can easily result in weak hatchlings that do not have the strength to hatch. Before setting eggs, calibrate you're a separate thermometer and hygrometer to double check the accuracy of your incubator readings. It is also advisable to manually check for warm and cool spots within the incubator. If they exist, then periodically moving eggs to different areas will help even out temperature variations.

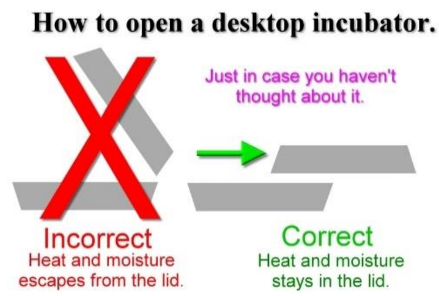
> ***THERMOMETERS****: Not all thermometers are suitable for incubation purposes. Many inexpensive digital instruments have an accuracy of only 1.8°F (1°C). This means that when the thermometer reads 99.5°F, the actual temperature could be anywhere from 97.7-101.3°F. For best results, use a thermometer that is suitable for incubation. See https://robertsfarm.us/thermometers.htm for further details.*

> ***TEMPERATURE MEASUREMENT LEVEL****: Many desktop incubator temperature probes are designed to lay on top of the eggs; however, heat layering may make such readings inaccurate. For best results, measure the air temperature at the middle of eggs. For mixed batches of large and small eggs, use the average egg height. If the eggs hatch on the target date, then you know your temperature is correct. If they hatch early, then your overall average temperature was likely low. If they hatch late, then your temperature was likely low.*



- **CABINET INCUBATORS**: When using my cabinet incubators, I frequently have chicken, turkey, pheasant, guinea, and peafowl eggs in the same incubator as my duck and geese. In such cases, I remove the duck/goose setting trays, set them on the counter, allow eggs to cool for the prescribed period, mist the eggs, give a few moments for most of the water to evaporate, and then place them back into the incubator.

- **DESKTOP INCUBATORS**: When I am using a desktop incubator, I will only incubate ducks and geese in that incubator. For cooling, I'll lift the lid, set it to the side, allow the eggs to cool for the prescribed period, mist the eggs, give a few moments for most of the water to evaporate, and then replace the lid. When removing the lid, I am careful not to tilt the lid trapping the heat and humidity… leading to a more rapid recovery of the heat and humidity.



- **AUTOMATED SETTINGS**: I incubate in Brinsea cabinets that are equipment with settings that permit automatic cooling, but I have not experimented using these settings as they substantially differ from my established protocols. For best results, follow the manufacturer's directions.

- **SMALL EGGS**: Small eggs have less mass and heat up and cool off more quickly than larger eggs. Thus, call duck eggs require far less cooling than large goose eggs. Care should be used not to cool small eggs excessively.[29]

- **WATER MIST**: Water used for misting eggs should be distilled or filtered water and held at room temperature. Some recommend adding a weakened antimicrobial solution to the water. If you decide to use such an agent, I highly recommend an agent that is labeled for use with hatching eggs such as Tek-Trol.

Antimicrobial Agents

Product	Active Ingredient	Research	Label	Efficacy
Bleach	Sodium Hypochlorite	Yes	--	Yes
Brinsea Egg Sol	Hal. Tertiary Amines	No	Yes	Unknown
Listerine Gold	Essential Oils	No	No	Unknown
Mannah Pro	Natural Enzymes	No	Yes	Unknown
Oxine AH	Chlorine Dioxide**	No	No	Unknown
Peroxide 3%	Hydrogen Peroxide	Yes	Yes	Yes
Tek-Trol	Orthophenol	Yes	Yes	Yes

- **TILT TURNER**: Large eggs are usually incubated on their side with the turner tilting the eggs 45° from center every hour. The eggs are also then rotated 180° daily. Eggs should be periodically moved to different locations to even out temperature variations within the incubator.

> ***REMINDER: TABLETOP TURNERS MAY BE INADEQUATE****: If the eggs are small enough to comfortably fit inside your tabletop turner, you still may want to consider hand turning. Many tabletop turners only tilt eggs 30° from center every 4 hours… this is insufficient for many waterfowl species.*

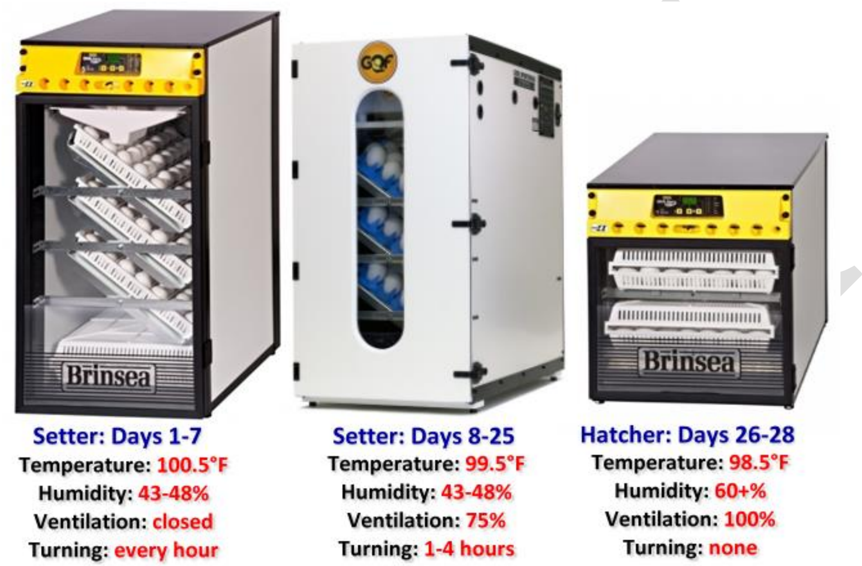
- **HAND TURNING**: If an adequate turner is not available, hand turning the eggs 180° at least three times each day, five times is preferred. Marking one side of the egg with a large X and the other side with a large O helps ensure that are eggs are fully turned at each session. Eggs should be periodically moved to different locations to even out temperature variations within the incubator.

- **VENTILATION**: Ventilation is one of the key pillars of incubation; however, its importance is often overlooked by the hobbyist. Frequently, a hobbyist will keep all vents closed until hatch-time or may keep vents open the entire time. While a balance must be achieved in incubators containing eggs in various stages of development, more ideal levels can be achieved in single stage incubators – all eggs in the same stage of development:

> *A mother hen will brood intensively during the first nine days of incubation, so ventilation around the eggs is low. As a consequence, oxygen levels are low and CO2 in the nest is high… limiting the amount of oxygen during the early embryonic stage leads to a better development of the chorioallantois, lungs and heart.*[30]

In the first few days the vents should be closed on the incubator to reach the required temperature as soon as possible but after that gradually the vents can be opened up to 50% by day 12 of incubation. Then between day 12 and 24 of incubation the vents can be open up to 75-80% and after that vents can be open 80-100% until transferring to the hatcher.[31]

- **FAUX SINGLE-STAGE INCUBATION**: I've discovered that starting eggs off at a slightly higher temperature with more frequent turning can result in a 5-8% improvement in the development rate; however, I do not incubate sufficient duck and goose eggs to fill an entire cabinet with a single batch. But, I can setup my Brinsea 380 to incubate eggs from Day 1 with a temperature of 100.5°F and then move those eggs to my Sportsman 1500 set at 99.5°F on Day 7 following candling. This involves a little more work, but also provides a more ideal environment for eggs.



- **SPRAYING & HUMIDITY**: Some believe that spraying waterfowl eggs is related to increasing the humidity. Interestingly, the opposite is true. A routine of spraying waterfowl eggs may temporarily raise the humidity inside the incubators, but it actually contributes to greater water loss long-term.[32]
- **CANDLING: INFERTILE vs NON-STARTER**: It is common within the hobbyist community to label any egg that fails to develop as "fertile" or "infertile"; however, this label is probably inaccurate as there are a number of reasons why a fertilized egg may not develop:
  - **What is an infertile egg?** An infertile is an egg that has not been fertilized.
  - **What is a non-starter egg?** A non-starter is an egg that has been fertilized but has failed to develop or has died within the first days of incubation – a blood ring may not be visible.

Once an embryo dies, it begins to deteriorate and is slowly reabsorbed into the surrounding contents.[33] To distinguish between infertile and non-starter eggs, the egg contents must be examined with a magnifying glass within the first few days of incubation.

WHAT DIFFERENCE DOES IT MAKE? Simply declaring all eggs that candle clear as "infertile" may cause the hobbyist to misidentify a problem and then fail to take corrective actions. Reasons why eggs fail to develop can include:

- Eggs stored too long
- Poor storage condition
- Unstable storage temp.
- Improper cleaning
- Non-porous egg shell
- Egg-borne infections
- High temp. in early incubation
- Very young or very old breeders
- Drugs, toxins, pesticides, etc.
- Infrequent or incomplete egg collection
- Inbreeding, chromosome abnormalities

- **MATING RATIOS**: The ducks and geese on my property are primarily for our enjoyment and breeding is secondary. Therefore, I'm not terribly concerned about reducing costs by minimizing my male population, and my male to female ratio is generally either 1:1 or 1:2. However, if a person is interested in reducing costs, has overly aggressive males, or maximize egg production (overly aggressive breeding can reduce egg production), then the number of drakes can generally be reduced to a 1:5-6 ratio.[34] Because geese are larger than most ducks, a lower male to female ratio is generally recommended:

Geese[35]		
African: 1:2-6	Embden: 1:3-4	Toulouse (non-dewlap): 1:3-4
Toulouse (large dewlap): 1:2-3	American Buff: 1:3-5	Pilgrim: 1:3-5
Pomeranian: 1:3-4	Sebastopol: 1:1-4	Chinese: 1:2-4
Roman Tufted: 1:2-4	Canadian (Domestic): 1:2-3	Egyptian: 1:1

***SPERM STORAGE**: How long will a duck remain fertile after the drake is removed? The maximum time that sperm stays viable is heavily dependent on the species. In Peking ducks, high fertility can be expected until the 5th day with a uniform decline thereafter with no fertile eggs after 15 days.*[36]

Pilgrim: 16 days *Embden: 14 days* *Muscovy: 13 days* *Mallard: 17 days* *Pekin: 15 days*

- **HATCH-TIME SETTINGS**: If things have gone well during the first 25 days of incubation, then the hatchling is likely to hatch ***even if the environment is less than ideal***. Because I hatch a variety of eggs in mixed batches, I'll occasional, accidentally skip over an egg when moving a batch to the hatcher. These eggs almost always hatch successfully despite being in a turner with an air temperature of 99.5°F and a humidity ~43%. They're not happy, but they hatch.

  Hatch-time humidity recommendations can vary widely… anything from 60-80%. Many believe that decrease drying time provides the hatchling more time to pip, zip, and escape the egg. While partially true, if the humidity has been correct Days 1-25, the egg contains sufficient fluid to keep the membranes lubricated throughout the hatching process. In fact, with waterfowl, I've found that once hatching begins, the humidity will naturally rise – in small desktop incubators, the humidity may rise to 100%. Yes, I've seen it rain inside desktop foam incubators. Personally, I prefer an initial humidity of 60%.

  Most hobbyists maintain a temperature of 99.5°F (37.5°C) during hatch-time. This practice probably originates back in the days when wafer thermostats dominated and fiddling with the thermostat with eggs present could be disastrous. With modern digital technology, we can now adjust temperature accurately. Hatching is a labor-intensive endeavor and occurs in a hot, wet environment. Reducing the hatch-time temperature by a single degree can help stave off heat exhaustion and reduce the number of hatchlings that pip but fail to hatch.

  High Temperature + High Humidity + Intense Labor = Heat Exhaustion

- **SAFETY BREATHING HOLES**: Because ducklings and goslings often take a long time to hatch, some people fear that they'll run out of oxygen. To correct this perceived problem, they may make a small breathing hole in the shell. While well meaning, this practice is detrimental to the hatching process:

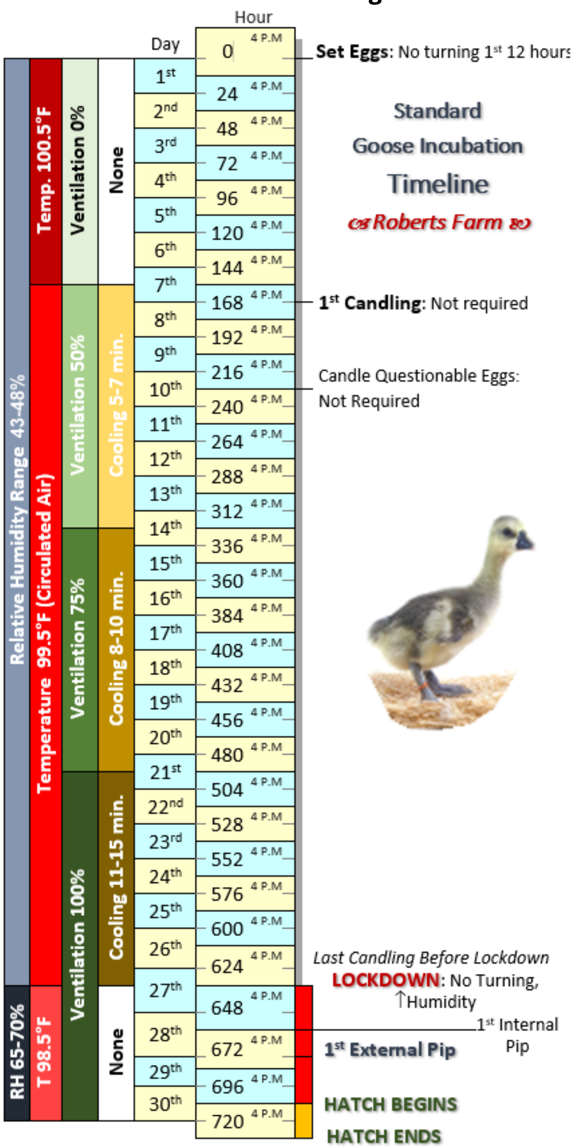
  > *In geese it is advised to have relatively higher (around 1%) carbon-dioxide concentration before pipping, because the lack of oxygen encourages the embryo to hatch and from the reaction of carbon-dioxide and water vapour we get carbonic acid that dissolves the egg shell and makes the hatching easier for the embryo.*[37]

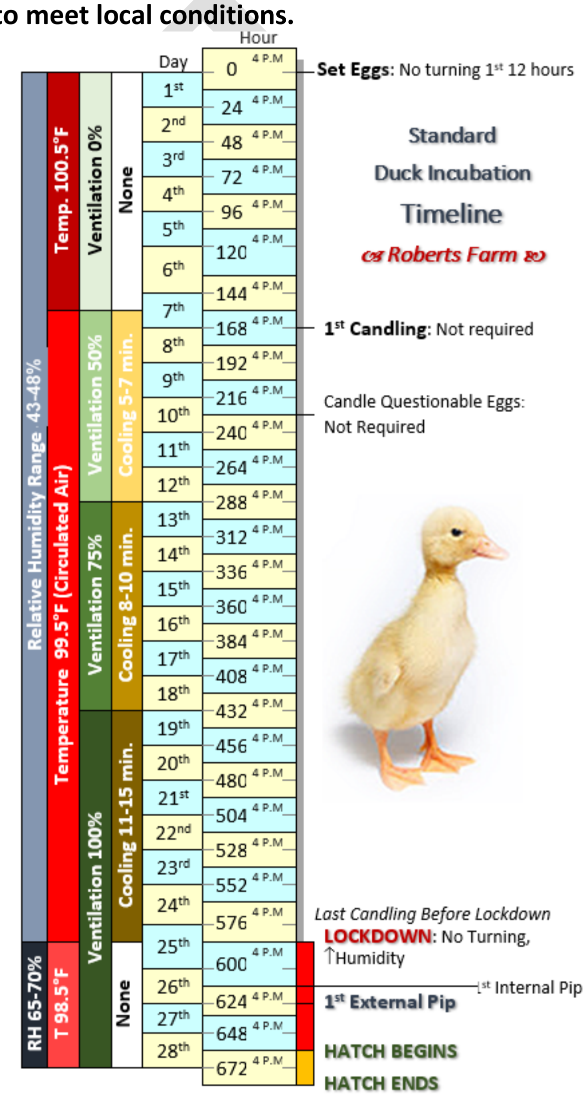
- **INTERNAL PIP TO HATCH**: Ducks and goslings take forever to hatch. Frequently, up to a third of my eggs have pipped internally when I move the eggs to the hatcher. Normally, the first pip will occur 36-48 hours prior to the hatch date and it can take 24-36 hours for a duckling to completely zip the shell and emerge. They will naturally rest between efforts so resist any temptation to help a tired duck from their shell.

> *While some birds that are assisted from the shell develop into fine specimens, a large percentage of them are usually handicapped by a deformity or weakness. When it is understood that the hatch is a fitness test given by nature to cull out the weak and deformed-protecting them from facing a life for which they are unprepared, we can take a more realistic view of helping ducklings from the shell.*[38]

SAMPLE PROTOCOLS

Settings should be altered to meet local conditions.





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