The Incubator Shop.co.uk

A Guide to Incubation

Welcome to The Incubator Shop's guide to incubation!

The purpose of this guide is to provide you, the user, with the knowledge, principles and techniques needed to successfully incubate eggs. As well as explaining the basics of successful egg incubation, this guide will provide troubleshooting tips; and address the common incubation problems.

For specific answers to commonly asked questions, you can also visit *The Incubator Shop*'s FAQ page.

The information below is based mainly on poultry egg incubation; however it is generally applicable to all species and any major differences between species will be explained along the way.

This guide to incubation is also available to read interactively on our website www.theincubatorshop.co.uk.

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The Basics

When incubating eggs, there are five key factors to bear in mind:

1. Temperature – With the egg at the correct temperature (for most species this is 37.5°C), the biological process of incubation will commence and the embryo will begin to grow. The correct temperature must be sustained throughout the incubation period.
2. Egg turning and positioning – As the egg is turned, the embryo will pass through the egg white, allowing it to gain fresh nutrients. As the embryo grows, correct positioning of the egg ensures that the embryo forms in the correct position for hatching.
3. Humidity – The shell of an egg is porous, meaning that water can pass through it. Over the egg incubation period, water passes from the egg to the air outside. Correct humidity ensures that the right amount of water is lost over time. It is important to remember that humidity will vary, and this is not a big problem; it is the average humidity that matters more.
4. Fresh Air – It is important to note that during incubation the egg breathes; it takes in oxygen from the surrounding air and releases carbon dioxide. A fresh air supply is vital to egg incubation and hatching eggs.
5. Clean Environment – During incubation, eggs are susceptible to infection. The warm, egg incubator is a perfect breeding ground for bacteria. Eggs should be clean and disinfected before egg incubation begins.

What species are you incubating?

There are two types of bird species and, although the basic principles of egg incubation remain the same, it is important to understand the differences between the two. Hatching a chicken is very different to hatching a parrot, or hatching a bird of prey.

1. Precocial Birds – These are birds such as poultry and waterfowl, which are capable of moving around after hatching.
2. Altricial Birds – These are birds such as parrots or birds of prey, which are incapable of moving around after hatching, and require more, intensive care brooding.

So what are the five main differences between the two types of bird?

Precocial Birds	Altricial Birds
Hatch with their eyes open	Hatch with their eyes shut
Hatch covered with down feathers	Hatch with little and sometimes no down feathers
Leave the nest within the first two days of hatching	Incapable of departing the nest
Will forage for food within hours of hatching	Fed by parents
Eggs are turned less frequently	Eggs are turned more frequently

The Egg

Eggs, like the birds that lay them, come in many different shape and sizes. However, their basic structure is always the same.

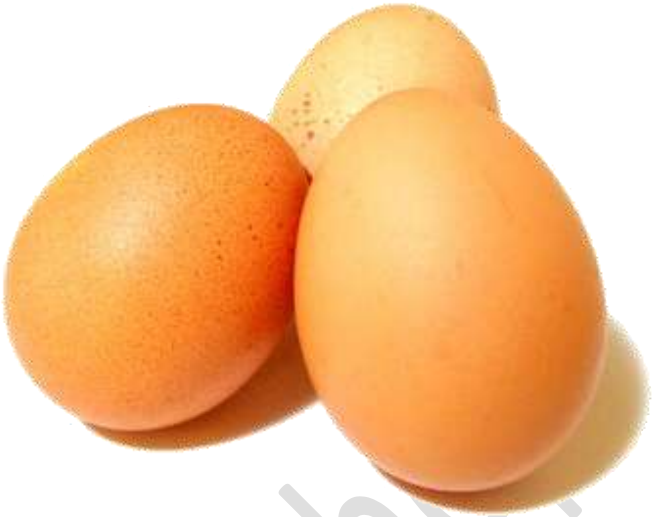
There are 6 main parts to a fertile egg: the shell, the shell membrane, the albumen (egg white), the yolk (yellow), the chalazae (supporting tissue) and germinal disc (the fertile area visible as a white spot on the egg yolk).

The Shell

Shells can often vary in shape from species to species, however, usually one end is round and the other end is more pointed. This means that if an egg happens to roll, due to wind or other elements, it never rolls too far from the nest; a clever evolutionary feat of Mother Nature.

The shell of an egg is porous; meaning liquids and gasses can pass through it. The porous shell of the egg allows an easy interchange of oxygen, moisture and carbon dioxide.

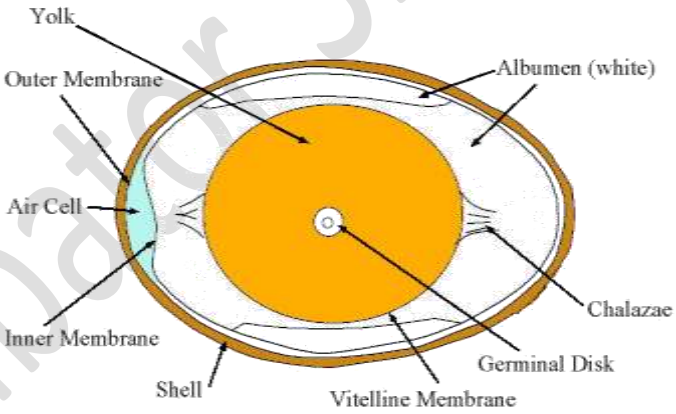
Another fascinating feature of the shell is that it is thicker and denser on the outside than on the inside. This allows the chick to break out of the egg much easier than a predator could break in.



Egg Yolk

The yolk is, in essence, the food store of the egg and is made up of water, proteins, fats, vitamins and minerals. This food store is not primarily used in the incubation of the egg as many people think, but is the main source of food for the newborn chick within the first few days of hatching.

Day old chicks do not require feeding straight away after hatching, as they have an adequate amount of food available from the egg.



Chalazae

These are spirals of supporting tissue within the egg white, or albumen. The Chalazae are connected at both ends of the egg, holding the yolk in its central position.

The spiral threads are coiled in opposite directions, meaning it is vital not to turn the eggs continually in one direction; this will result in one of the threads becoming too tight, whilst the other becomes too slack. Eventually one will snap and the yolk will not be able to keep its position inside the egg.

During egg incubation, eggs should be turned through roughly 45 degrees in both directions; the chalazae will therefore remain intact.

Shell Membrane

There are two main membranes inside the egg. The outer membrane lines the inside of the shell; whilst the inner membrane is only loosely appended, separated from the outer membrane at the broad end of the egg by the air sack (also known as the air cell). During incubation, the space between the two membranes increases as the egg looses moisture; this increases the air supply available to chick in the final few days before hatching.

Albumen

Also known as the "white" of the egg, the albumen is composed of protein, water, vitamins and minerals. The albumen's primary purpose is to protect the yolk from damage. However it is also a food store for the growing embryo during the egg's incubation.

The albumen is composed of three different layers, each performing different function. The thin, watery outer layer has contact with the inner and outer membrane and allows the diffusion of gasses and moisture with the outside world.

The thick and viscous, jelly-like, inner layer provides a cushion for the delicate yolk, absorbing any shocks that the egg may suffer. The inner-most layer of the egg white is also thin and watery, acting as a lubricant for the egg yolk, allowing it to rotate freely in the middle of the egg. This ensures the yolk and germinal disc have ready contact with fresh supplies of food and oxygen.

Germinal Disc

The germinal disc is the fertile part of the hatching egg; the part where the male and female cell unite. When the egg is under a broody hen, or in correctly calibrated egg incubator, the cells will begin to divide. Incubation and embryonic development have begun.

Nutrition of the egg

The egg is made up of many nutrients, vitamins and minerals that come from the parent. Hens need a variety of nutrients at least two weeks prior to laying.

The most important nutrients are:

- Vitamin A – Obtained from green feeds and vegetables; a lack of Vitamin A causes poor hatch rates, weak chicks and poor resistance to disease.
- Vitamin D – Obtained from sunlight; a lack of Vitamin D causes weak bones and misshapen eggs.
- Vitamin E – Obtained from seed germs (i.e. Wheat); a lack of Vitamin E can result in weak chicks and circulatory failure.
- Vitamin K – Found in most green feeds; a lack of Vitamin K can cause haemorrhaging.

How the egg is formed

The hen's ovaries are positioned in the back of her abdominal cavity. There are several yolks inside the ovaries, at different stages of development. As they grow larger over time, the yolks move to the top of the oviduct passage, which eventually lead to the uterus.

In the upper-oviduct, the male sperm fuses with the female cell in the yolk. The fertilised yolk then travels down the oviduct (or egg canal) where it acquires coatings of albumen (egg white) followed by the shell membranes, the shell gland produces the shell and the completed egg travels to the uterus.

By the time the egg reaches the uterus, the hard shell has completely formed. It then moves to the vagina to be laid. This whole process usually takes 24 hours, however can sometimes take 36 hours.

Egg Collection, Storage and Handling

Egg Collection

It is best practice to collect the eggs before 9am and to check back at midday in case the hen has laid any more eggs. However, the more frequently eggs can be collected; the less chance there is of them becoming soiled or dirty. Eggs that are left in the nest for more than 24 hours tend to result in poor hatch rates.

Eggs are usually collected in a basket or rubber bucket. It is very important that eggs are handled carefully to avoid them getting jarred or cracked. Many people add an extra layer of kitchen roll or wood shavings into their basket for increased security.

It is also important to wash ones hands before collecting the eggs. Your hands are the perfect breeding ground for bacteria and this can easily be spread to the eggs. If your hands are sweaty or greasy, this too can pass onto the eggs; blocking their pores and preventing respiration and moisture loss – all of which can affect the chances of a hatch. Before collecting the eggs, wash your hands carefully with anti-bacterial soap or incubation disinfectant. Rubber gloves can also prevent the spread of germs and bacteria.

Storage

Egg storage is an optional step before egg incubation. Many breeders prefer to build up a “batch” of fertile eggs before commencing egg incubation. The duration for which to store your eggs is completely up to you. However, it is not recommended to keep your eggs any longer than 10 days before incubation.

Cleanliness

During storage, it is very important that you ensure the quality of your eggs. Cracked, misshapen or heavily soiled eggs should be discarded to avoid contamination. Some slightly dirty or soiled eggs can be washed with incubation disinfectant. When washing eggs, make sure that the water or solution you use to clean the eggs is significantly warmer than the egg temperature; this will cause any bacteria to be drawn away from the pores.

Washing your eggs is highly recommended. However it is important to note that this process will remove the egg’s natural, thin outer coating. This will leave the egg vulnerable to future infection so it is vital a high level of cleanliness is maintained throughout the egg incubation period.

Storage Temperature & Humidity

When storing eggs it is recommended to keep them at a room temperature of between 15°C and 18°C. Cool, draft free locations are an ideal place to store your eggs. Before incubation, eggs should

be brought steadily up to room temperature. This avoids drastic temperature changes and “thermal shock” to the egg.

As for humidity, lower is better, but not essential. Some breeders recommend a humidity level of between 45% and 55% RH; this is ideal. However, unless you plan to incubate eggs on a large scale, small differences in humidity are unlikely to make any difference to hatch rates.

Egg Turning During Storage

During storage, eggs should be turned a minimum of once a day; two or three times per day is much better.

When turning eggs, try to make sure each egg is turned 45 degrees each way, totalling 90° over the course of a day. Turning the egg during storage ensures the eggs outer membrane does not stick to the shell.

The method you use to turn your eggs is up to you. Some people prefer to turn their eggs manually by hand, whereas some prefer to place their eggs pointy side down in an egg box at an angle, and change the angle of the egg box two or three times a day. However a growing number of people use their egg incubators to turn their eggs before incubation. This can be achieved simply by using removable automatic egg trays, or by placing the eggs in the bottom of a rocking incubator with just the rocking motor on.

Egg Handling Tips

Eggs should always be handled with the upmost care. Severe bumps may rupture the egg’s internal membrane, even if the egg shell appears undamaged.

Care must still be taken when handling eggs in the incubation stage. A severe bump can rupture blood vessels; causing the chick to bleed to death.

If eggs have endured a lot of handling, perhaps from being sent in the post, it is important to set them pointy side down for at least 24 hours before incubation. This will allow the contents of the egg to settle.

Choosing the right Egg Incubator

An egg incubator is a machine that artificially provides an egg with the correct environmental conditions to successful grow and hatch a chick.

When purchasing an egg incubator or egg incubation equipment it is always recommended to purchase the absolute best you can afford. There are many egg incubators for sale on the market so it is very important to conduct a little research before deciding on an incubator. Many people choose to borrow an egg incubator from a friend first so they can try hatching eggs and to understand the egg incubation process.

When searching for suppliers of egg incubation equipment, check on the support available and the after-sales service offered. Cheap egg incubators are often supplied with little to no after-sales support so be sure to purchase your egg incubator from a reputable incubator shop.

Still air or fan-assisted?

Egg incubators can be still air or fan assisted (also known as "forced air"). In still air egg incubators, air circulates by convection; as the warm air rises in the incubator, it displaces colder air. This cycle creates natural air circulation. However, in still air egg incubators, it can be much harder to establish the correct incubation and hatching temperature. This is due to the fact that some parts of a still air incubator are cooler than others. If the incubating eggs are on more than one level, a still air egg incubator can result in poorer hatch rates.

The alternative to still air egg incubators is fan-assisted, or forced-air, egg incubators; in which the air is forced over the eggs and throughout the incubator by means of a fan. Fan-assisted egg incubators are becoming increasingly popular due to their increased chances of success. Larger, cabinet incubators need to be fan-assisted due to the volume of warm air needed inside the egg chamber.

Turning Method

There are three main types of egg incubator available on the market;

Manual incubators

Semi-automatic incubators

Fully automatic incubators

Manual Egg Incubators are simply a heated box controlled with a thermostat. Eggs need to be turned individually by hand. For people looking for cheap egg incubators, manual egg incubators are often a popular choice; homemade egg incubators are often manual.

Semi-automatic egg incubators do not require eggs to be individually turned; instead, the whole batch of hatching eggs is turned at the same time by an external control or lever. The turning method on semi-automatic egg incubators differs from model to model.

Full automatic incubators will automatically turn the eggs throughout the day. The way in which the eggs are turned varies from model to model, however the most popular methods are via a moving floor; or by sitting the egg incubator in a turning cradle, to rock the whole machine from side to side.

Temperature and Humidity Control

In modern incubators, the heating element is almost always powered electrically through a standard rated electricity supply. The incubator's thermostat plays a key role in ensuring the correct

incubation temperature is present throughout the incubation period. Modern, electronic thermostats are much more accurate than their traditional counterparts; such as the "wafer thermostat". The main benefit of digital thermostats is their acute sensitivity to temperature fluctuations; they are able to respond instantly to environmental changes, turning heat on or off as necessary.

An accurate and easy to read thermometer is also an incubation necessity. Today's thermometers are either liquid in glass or digital. Many people have individual preferences to their chosen thermometers; however with both types it is vital that the thermometer's probe is as close to the eggs as possible. This will give the most accurate estimate of the temperature inside the incubating egg. Some still-air incubators may have cold patches inside the egg chamber so be sure to think carefully about the positioning of the thermometer. It is always highly recommended to follow manufacturer's instructions wherever possible.

Many incubators control humidity using a simple water reservoir in the base of the egg chamber; such reservoirs are topped up manually as many times as is advised by the manufacturer. Other machines use a humidity block or pad that need to be kept moist throughout the incubation period. When topping up an incubator's water levels, it is important that the water is not too cold; this can result in a dramatic temperature reduction within the egg chamber. Similarly, it is just as important that the water is not too hot. Try where possible to ensure that the water is around 37.5°C.

Of course, some modern incubators are fitted with highly accurate digital humidity pumps. These take human guesswork away from incubation, leading to much more accurate humidity levels. This level of accuracy, although desirable, is not vital to successful egg incubation.

The Egg Incubation Process

Stage 1 (Fertilisation)

The yolk is dropped from the ovary and fertilised by the male sperm. The fertilised yolk then travels down the egg canal and receives several coatings of albumen (egg white). The shell is then developed in the hen's shell gland. This process takes approximately 20 hours; after which, the egg is laid.

Stage 2 (Days 1 and 2)

The egg is hatched and gradually cools. At this stage, embryonic growth slows and often stops. Many birds will develop a "clutch" of eggs that they wish to incubate. The clutch size depends on a variance of factors including hereditary traits and environmental factors.

For artificial incubation, the breeder can actively choose the clutch size they wish to incubate. He or she may choose to store the eggs at room temperature (15-18°C) for up to 10 days in order to gather the required amount of eggs.

On the first day of incubation, embryonic growth begins again and the cells begin to divide and multiply rapidly. By the end of day one, the head, eyes, nervous system and circulatory system have begun to form. The heart is formed on day two and is functioning within 48 hours of incubation.

Stage 3 (Days 3 and 4)

On day three, the heart develops from its simple form to become a fully functioning, beating heart. Additional membranes are formed in this time. This creates the amniotic sack which the embryo will float in for the duration of incubation.

Within the amniotic sack; amniotic fluid, combined with correct egg turning, ensure the embryo orients itself correctly during hatching.

Although the heart is still positioned outside the body, by the end of day four, the legs and wing buds have began to form.

Stage 4 (Days 5 – 10)

By the end of day six, the legs and wings are nearly complete. Feathers begin to appear at day eight, and by the end of day nine the embryo is beginning to look like a chick - the chicks heart is now in place within the body. By day ten, the bones are beginning to form.

Stage 5 (Days 11 – 21)

By day thirteen, the chick's down feathers are fully formed and present on most of the chick's body. The legs and wings are also complete with bones and muscle tissue. By day sixteen, the beak, leg scales and claws are very nearly complete. The remaining yolk then becomes a food source for the developing chick; this is used up by day nineteen.

At day nineteen, the chick is beginning to struggle to get enough oxygen to its blood; carbon dioxide levels in the chick's blood begin to rise dramatically. A rise in the CO^2 level within the chick's blood causes the chick's neck to twitch; its beak is forced through the membrane sack into the air sack at the blunt end of the egg.

The beak then opens for the first time and the lungs inflate; fresh oxygenated blood is then circulated around the body. At this point in the incubation period, the chick is under significant stress; many chicks die at this stage of incubation because they are too weak or undernourished to deal with the stress they are under.

Stage 6 – Pipping (Day 20)

A day or so before hatching, the chick begins to "chirp". Chirping is the sound made by the chick in an effort to communicate with its mother. The mother then naturally chirps back encouragement. In artificial incubation, some breeders enjoy chirping back to the chick to encourage it to hatch.

The chick continues to breathe from the air sack but soon begins to run out of air. This again begins to cause the chick's neck to twitch involuntarily. At this stage the chick's beak begins to penetrate the outer shell; this is known as "pipping". The chick's legs begin to move and twitch which causes the chick to move around inside the egg and the hole gets bigger. After an initial hole has been made, it is likely that the chick will pause (sometimes for up to 24 hours) to regain some strength and energy.

By the time pipping begins, egg turning should have ceased. This is very important as on day twenty, the chick gets itself into its ideal hatching position inside the egg; egg turning at this point would completely disorientate the chick and may result in injury or death.

Stage 7 – Hatching (Day 21)

On day 21, the chick will make a determined effort to chip off the top at the pointy end of the egg. The chick takes its first gasp of air as the top of the egg is released. It will usually rest for a while here, but will then go on to prise off the bottom half of the shell.

The hatching process takes time and the chick is visibly exhausted after its ordeal. When the chick hatches it is likely to be wet, but all the yolk should be absorbed into the chick's stomach. If there are any large pieces of yolk attached to the chick's bottom that were not absorbed into its stomach, the chick has a hernia and unfortunately will not survive.

The newly hatched chicks will stagger clumsily around the incubator or nest stopping for frequent rests. Do not worry; it is often the case that some chicks appear very tired and unwell after they have first hatch. But after a short rest, chicks are very likely to spring back to life at the first sign of a stimulus.

Never turn off the incubator too early. Some eggs will naturally hatch later than others. Leave the un-hatched eggs in the incubator for at least another 24 hours after the expected hatch day; you never know, they may just surprise you. Remember to resist the temptation to keep opening the incubator. Chicks are very sensitive to the cold and, by opening the incubator lid, valuable heat energy is lost. Chicks will happily remain in the incubator for 48 hours after hatching. They will not need any additional food and water during this time, as they will have enough food remaining in their bodies from their time inside the egg.

After 48 hours in the incubator after hatch day, the chicks should then be moved into a brooder. Brooding equipment can be found on our website; www.theincubatorshop.co.uk.

Optimum Conditions for Incubation and Hatching

Birds						
Bird Species	Temperature °C		Humidity RH%		Pipping	Hatching
	Incubator	*Hatcher*	*Incubator*	*Hatcher*	(Days)	(Days)
Chickens	37.5	37.0	52	75	18	21
Ducks	37.5	37.0	58	75	25	28
Muscovy	37.5	37.0	60	75	31	34
Ornamentals	37.5	37.0	55	75	19-27	22-30*
Geese	37.5	37.0	55	75	28	31
Chinese	37.5	37.0	55	75	27	30
Light	37.5	37.0	45	75	27-30	30-33*
Heavy	37.5	37.0	50	75	31-33	34-36*
Turkeys	37.5	37.0	55	75	25	28
Guinea Fowl	37.5	37.0	55	75	25	28
Quail						
Coturnix	37.5	37.0	45	75	15	18
Bobwhite	37.5	37.0	45	75	20	23
Chinese Painted	37.5	37.0	45	75	12	16
Pheasants						
Game	37.5	37.0	50	75	21	24
Ornamental	37.5	37.0	50	75	20-25	23-28*
Partridges	37.5	37.0	47	75	20	23
Peafowl	37.5	37.0	50	75	25	28
Pigeons/Doves	37.5	37.0	50	75	12-13	15-16*
Falcons	37.0	37.0	40	45	31	33
Merlins	37.5	37.0	50	50	28	32
Swans	37.5	37.0	50	75	26-32	30-36*
Ostrich	36.0	35.5	30	75	35	42
Emu	36.0	35.5	40	75	46	50-52
Rhea	36.0	35.5	40	75	33	36
Parrots	37.5	36.6	50	75	15-26	18-29*
* Varies depending on species						

Troubleshooting

Problem	Possible Causes
Chicks hatch late	• Large Eggs • Old Breeding Stock • Eggs have been stored for too long • Weak embryos • Inbreeding • Incubator Humidity too high
Slow (drawn-out) hatch	• Mix of eggs (different sizes, different aged breeding stock, different storage times) • Poor egg handling • Hot or cold spots in the incubator • Incubator or Hatcher temperature too high or low
Sticky Chicks, smeared with Albumen (Egg white)	• Low incubation temperature • High incubation humidity • Poor egg turning • Old eggs • Very large eggs
Chicks stuck in shell, dry, shell fragment stuck to feathers	• Low humidity in storage • Poor egg turning • Cracked shell or poor shell quality
Premature hatching, bloody navels	• Temperature too high
Small chicks	• Small eggs • Low humidity • High temperature • High altitude • Thin, porous shells
Unhealed naval, dry, rough down feathers	• High incubator temperature or temperature fluctuations • Humidity too high when hatching • Inadequate nutrition
Weak Chicks	• High hatching temperature • Poor hatcher ventilation • Contamination
Chicks malpositioned	• Eggs sat small end up position • Inadequate turning • Excessive turning at late stages • Too high or too low temperature • High humidity • Old breeders • Round shaped eggs • Nutritional deficiencies • Retarded development • Poor egg handling or storage conditions
Malformations	• Poor storage conditions • Jarring of eggs

	• Nutritional deficiencies • Inadequate turning • High or low temperature • Inadequate ventilation
Crooked toes, bent legs	• High or low temperature • Poor nutrition (especially vitamin B)
Short down, wiry down	• Nutritional deficiencies (especially riboflavin) • High incubation temperature
Eyes closed, down stuck to eyes	• Temperature too high in hatcher • Chicks remain in hatcher too long after hatching • Excessive air movement in hatcher
Exploding eggs	• Dirty eggs from nest • Eggs not washed properly • Water condensation on eggs • Water sprayed on eggs • Contamination from earlier exploders • Contaminations from handling with dirty hands
Dwarf embryos, runts in growing chicks	• Egg contaminations • Breeder diseases • Nutritional deficiencies
Haemorrhage	• Incubator or hatcher temperature too high • Rough handling at transfer • Nutritional deficiencies (vitamin K or E) • Contamination
Swollen head and back of neck	• Nutritional deficiencies
Small air cell, egg weight loss under 10%	• High humidity • Very thick shells • Low temperature
Exposed brain	• High incubation temperature • Low oxygen levels

Further Reading

For further reading on the subject of egg incubation, hatching and rearing we have prepared a list of recommended books:

Katie Thear (1987). *Incubation – A Guide to Hatching and Rearing*.

Katie Thear (1987). *Keeping Quail*.

Katie Thear (1999). *Starting with Chickens – A Beginners Guide*.

Katie Thear (2002). *Starting with Ducks*.

Katie Thear (2003). *Starting with Geese.*

Katie Thear (2007). *Starting with Turkeys*.

Alison Wilson (2009). *Chicken Keeper*.

Thanks for reading!

We hope you have found this guide useful for both choosing and using your incubator. At The Incubator Shop, we pride ourselves on a first class customer service and, as such, want to provide you, the customer with as much advice and support as you need.

If you have any further questions relating to incubation products, or the field of incubation; please feel free to contact us by email at sales@theincubatorshop.co.uk, or telephone on +44 (0) 1482 865080.