Artificial Incubation Basics

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First, let's ask ourselves why we want to pursue using artificial incubation techniques. For most of us the answer is quite simple, we are able to increase production of young birds and we are in control of the destiny of the egg. There is a great deal of satisfaction in assisting a new life to enter this world of ours.

In the past 17 years, I have had the very great pleasure of using artificial incubation to hatch hundreds of birds (mostly exotic pheasants). It is a very satisfying and enjoyable experience if you are successful but for those who are not successful it can be a most heartbreaking and unpleasant experience. I do remember my very first experience and it was most disappointing. I did not hatch a single bird but as I look back, it was a valuable learning experience. It caused me to dig for information on how to improve my incubation techniques because I love a challenge and basically want to be successful at everything that I choose to undertake. One of the directions I tried was to join a bird club (CGBA). I remember attending meetings and set about picking the old timers' brains. I can now laugh at some of the advice I was given in those conversations. I really should have been more selective and only sought advice from people who were successful bird breeders because I did get some very poor advice from breeders who were knowledgeable about birds in general but weren't knowledgeable about artificial incubation. So for those of you who are having difficulty in the artificial incubation process I suggest you seek advice from successful breeders and take notes.

Over the years, I have had the opportunity to listen to many breeders' tales of woe and have formed some distinct opinions about incubators and the people who use them. Since I have learned a great deal about the incubation process, I will attempt to relay what I perceive to be the most important aspects of the incubator and your operation of it.

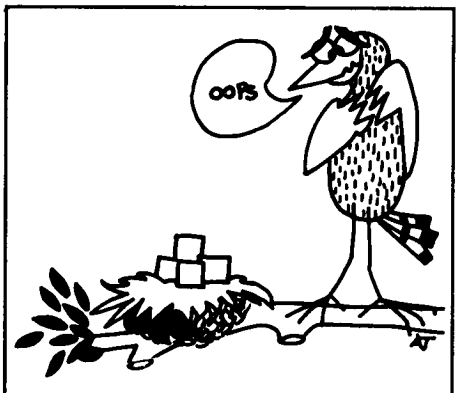
Before discussing the incubator and its operation, let's examine the operator's personality. I am convinced that the use of the incubator to increase production and raise birds is not for everybody. Why would I be so bold to make such a statement? The answer is simple – some people do not wish to pay attention to details, winging it is a way of life for them. For these people, allowing the parents to incubate and rear their young is definitely the best course to follow. Many of us are too wrapped up in our jobs, family life and other outside interests to be attentive to the needs of the detailed operation required with incubators. Please do not misunderstand this comment, I'm simply trying to warn those who do not have time to pay attention to details that they may be better served not to try artificial incubation.

For those who want to be more successful, I will attempt to explain some basics of this exciting hobby. I have had the opportunity to repair and modify a number of incubators for people over the years. In doing so I can safely identify a number of improvements for you. The incubator and hatcher that I am currently using can best be described as basket cases before I was able to modify and improve their operation to my satisfaction.

First, let's think about the very most important aspect of an incubator. I'm sure many of you can think about what is important in the way of cost or size, but I'm talking about the environment for these precious eggs of ours. What we are attempting to do is create an environment equivalent to that of the parent bird. Notice that I used the term "equivalent" as opposed to "identical." Most of us will use a forced-air incubator and not a still-air incubator (much more difficult to control a thermal gradient than a constant, uniform temperature). The egg under the parent or surrogate creates a rather constant and consistent thermal gradient across the egg. Heat is transmitted to the egg by conduction and radiation. Since the breast cannot completely cover the egg, the portion in contact with the breast will be warmer than the opposite side which is in contact with wood chips or similar materials. This side which is not in contact with the heat source is actually losing heat and therefore a thermal gradient will exist. This has been as much as 6°F on relatively small eggs. The forced air incubator transmits heat to the eggs by convection (heated moving air) and creates a uniform and constant thermal temperature environment. The *key* to successful hatches is keeping this temperature uniform, constant and by all means at the proper level.

The number of incubator manufacturers and models available is on the increase and it is not the purpose of this paper to guide you toward one model or one manufacturer over another, but to help you decide what to look for or how to improve yours. Please be careful not to procure some old chicken incubator just because it was a bargain. Many old incubators are fine for chickens but not for the exotic bird eggs we are wanting to put into them. These old incubators (family keepsakes) do not have some of the improved temperature controls or reliability of some of our more modern types. The biggest flaw of many of these incubators is the very poor heat distribution and thermal gradients within them. You may find several degrees' difference in temperature between two adjacent trays.

Back to the most important physi-



Two detailed charts referred to in Aug/Sept '92 "The Crowned Pigeons" by Dave Wetzel were inadvertently omitted. A copy of this material can be obtained by writing the AFA office, P.O. Box 56218, Phoenix, AZ 85079-6218, or call (602) 484-0931.

cal aspect of your incubator. Have you guessed the answer yet? I am sure if given a test of this question, most people (90%) would get it wrong. It is the *temperature measuring device.* As I stated earlier, I have reviewed a number of breeders' incubation setups and found this very vital aspect of their operation to be the most serious cause of incubation failures.

If I had to guess as to the biggest reason for incubation/hatching failures, it would be the instrument used to measure the temperature within the incubator or hatcher. The second reason would be the placement of this temperature measuring device. By changing the quality of this device or its placement within the incubator, you can have dramatic effects on the outcome of the hatchability of the egg. First, let's discuss the temperature measuring device which you have been using in your incubator. If you are using a glass thermometer, what is the smallest division you can see? Hopefully, it is at least 0.25°F but, if it is 0.20 or 0.10°F this is much better. Some of the thermometers supplied with incubators are divided into increments of 1.0°F. These may he adequate for poultry but certainly *not* for the exotic types of birds we are trying to raise. When you think about it, the closer you are to the *"ideal"* temperature for the species you are attempting to raise, the better your chances for success. One possible method for checking the accuracy of your thermometer is to place the bulb end under your tongue and measure your own body temperature which typically should be 98.6°F. Sometimes this method is not possible because the bulb is too long. Checking the accuracy of your thermometer is an absolute must for the successful breeder. One thermometer I have been recommending for years is the ASTM model 18F. It is an 11-inch mercury thermometer which is graduated in 0.20°F divisions. Of the 27 thermometers (from three different suppliers) that I have personally tested against a secondary standard which is traceable to the National Bureau of Standards, the worst error was only 0.10°F. By ASTM specification standards the accuracy tolerance is ±0.20°F, but most manufacturers easily meet or exceed this accuracy requirement. I use this type of thermometer and highly recommend it for every serious breeder.

I want to warn everyone using a thermometer to make sure that no air gaps or spaces exist in the mercury or red liquid column. If a space exists it will cause a serious error in the temperature measurement. If a space exists in your thermometer you can correct it by placing it in the freezer for 10 minutes which should shrink the liquid into the bulb portion. Then give the thermometer a downward shake and this will cause the liquid to recombine. If you are not successful on the first attempt try again. Occasionally a small amount of heat is necessary for red liquid types. For these thermometers, place the bulb portion of the glass stem under the hot water faucet and allow the liquid to expand to the top expansion chamber, then give it a good shake to recombine the fluid. Again, repeat if not successful on the first try. The very best attribute of a quality thermometer is its excellent stability and reliability (assuming of course that it doesn't become broken). To me a quality thermometer is worth its weight in gold because it will provide a lifetime of service without any degradation over time and is the singular most important part of my ability to be a successful breeder.

For those breeders who are using a dial type temperature indicating device, I do not recommend them. The first reason is that I have yet to find one in which I can discriminate (accurately) to at least 0.25°F. These devices are not inherently more accurate than ±1.0°F. I can recall a friend showing me a rather good looking dial indicator with the pointer between the individual 1.0°F marks. This method of determining the temperature between marks is called interpolation (fancy word for guessing). What is not understood is that although it was compared to the adjacent thermometer it is still possible for this device to have an increasing error with time because of the principal used to manufacture these devices. These devices have a bimetal spring which unwinds (causing the pointer to move) due to the temperature change. With time, these devices will degrade (causing an error in the indicated temperature) because the spring will work-harden or effectively wear out. These devices are for coarse temperature measurements. Typically, the accuracy statement for these devices is ±1.0°F at best. Therefore you must be able to accept an error of ±1.0°F, which is excessive for the serious breeder.

The next type of temperature measuring device used in incubators is the digital display temperature monitor. These can be excellent devices, but a word of caution is necessary here. Before purchasing one of these devices, you must read the accuracy statement. Although many have the capability of reading to tenths of a degree, this does not mean that it is accurate to within a tenth of a degree. These devices are generally more accurate if the temperature probe or sensor is a thermistor, or an RTD. Those using a thermocouple as the sensor are not as accurate or stable. One of the easy methods of checking the accuracy of these devices is to take your own body temperature as described previously.

I cannot over emphasize the importance of using an accurate temperature measuring device for your incubator, but the placement is equally important. The temperature measurement in close proximity to the eggs is the only measurement of consequence in your incubator. The sensor *must* be very near the eggs because a significant error could be present if you place the sensor in a position which is for your reading convenience only. Use a flashlight or magnifying glass if you have to in order to see the temperature reading scale. DO NOT assume that the temperature is the same everywhere within the incubator unless you have placed multiple sensors within the incubator to verify this. Remember the *only* area of temperature concern within your incubator is where the eggs are placed. It makes no sense to measure the temperature within the incubator unless it is in very close proximity to the eggs.

Again I want to reiterate the importance of the quality of your incubator's temperature measuring device because before you can control the temperature you must be able to measure it accurately. Remember, the most significant incubation parameter the parent bird is able to control is his or her body temperature which is generally as stable as yours or mine.

Next in importance concerning the incubator is the quality of the temperature controller. If your incubator is using a microswitch and thermal wafer to control the temperature, you should understand that without maintenance (replacing the thermal

wafer annually and microswitch every few years) that this system will degrade and eventually fail with time. The thermal wafer work-hardens with expansion and contraction which makes it stiff and less sensitive to temperature changes with accumulated time. The microswitch will not last forever either because the berilium copper spring will also work-harden with time and fail. When the microswitch fails it generally causes the incubator to overheat because the microswitch is used to turn off the heat when it gets too high. Additionally, by today's standards this is an archaic method of temperature control. Although this method is used in many older or less expensive incubators it can still do the job, but solid state methods (no moving parts) can be much more sensitive to temperature changes and can be much more reliable.

The contact thermometer used in some manufacturer's incubators can also be a stable and reliable method of temperature control. So if you're buying or considering modifying an incubator, be sure to inquire as to the method of temperature control. A good controller is very sensitive to temperature changes(±.25°F is good, but ±0.1°F is better). Above all, it must be *reliable*. Although this area of incubators is deserving of much discussion, space does not permit all of the pros and cons of these devices.

The next parameter of importance to be controlled in incubators is humidity. Without a doubt it is one that is the least understood and most often semi-ignored. Many people simply guess at this parameter. The reason that they do is the difficulty they have with trying to get the proper wet bulb measurement. Assuming you chose the wet bulb method (most people dislike it) to measure the relative humidity, you must remember several important steps to accomplish this properly. First, the wick must be totally free of any contamination. Try to handle a fresh wick with clean washed hands (free of oils) and minimize handling in attaching it to the wet bulb thermometer. It should be slightly snug on the bulb portion of the thermometer if it is to work properly. It is the evaporation from this area of the wick which causes the temperature to decrease. Next, the wick end *must* be allowed to be immersed into distilled water. Tap water with dissolved minerals will clog the wick's ability to draw water within a matter of an hour or so. This renders the wick useless because the proper flow of water cannot be maintained resulting in an incorrect reading. A wet bulb which is reading the same temperature as the dry bulb is an indication that the wet bulb is *not* functioning properly and is useless as a relative humidity reading. Another item which many people do not understand is the importance of the wet bulb being in a flowing air stream. It is the moving air (must be at least 3 feet per second) which assists the evaporation from the wet wick. Therefore, a wet bulb method in a still air incubator is absolutely useless as a relative humidity measurement. Don't forget that a psychrometric chart must be consulted with the wet/dry bulb method for determining the actual relative humidity.

Hygrometers, dial reading devices, are replacing the wet bulb method for the serious breeder. It can be a 3 or 4 inch diameter disc which when placed into the incubator can read the relative humidity directly. These devices can be accurate to within ±3% which is about the accuracy of a good dry/wet bulb combination.

In reality, by controlling the relative humidity within the incubator you are really controlling the weight loss of the egg. As a rule of thumb, most eggs seem to do well with a 15% weight loss over the entire incubation period, but some chicks still manage to hatch at considerable variations from this ideal weight loss. By experience, you will learn the relative humidity which is ideal for your type of eggs so that weighing of eggs (although desirable) is not absolutely necessary. I personally do not find it necessary to weigh my eggs.

To control the relative humidity within your incubator, you must control the amount of surface area of the water (preferably distilled) within the incubator. The amount of water to be added will depend to a large degree on the relative humidity of the air outside of the incubator. For those who cannot get the incubator's relative humidity down low enough without water in the incubator, you will be forced to use a de-humidifier within the room to remove the excessive moisture. For most of us who live in a much less humid environment, it is a simple matter to slowly add to the water level and ultimately achieve the desired relative humidity. Some people tend to panic if this relative humidity increases suddenly. This is generally caused by a rain storm which can be an event of short duration. If the humidity is too high over several days it can easily be corrected by decreasing the humidity for several days. I have used this technique many times with no detrimental effects to the egg's hatchabiliity.

Another parameter which can affect egg hatchability is the turning of the egg at regular intervals. Most breeders would agree that the first trimester is the most important and that turning is accomplished with certainty. In previous work accomplished by this author it was found that an Eclectus Parrot turned her egg 24 times in a 24 hour period. Most incubators with turning devices do turn the eggs on an hourly basis. For those who turn eggs by hand this can be a rather demanding task and generally will interfere with one's sleeping habits if this interval were maintained. Therefore regular odd numbers of turns in a given 24 hour period is recommended. Failure to accomplish a regular turning schedule will result in deformed chicks if they do successfully hatch at all.

In summary, I have tried to discuss some basics of incubation in an abbreviated manner and attempted to highlight what I have found to be some serious problem areas for breeders who are still having difficulty. Those who do not overcome the problems associated with artificial incubation will generally give up on the propagation of birds and perhaps the entire hobby (or business). Therefore to those who really have the desire to succeed I would urge you to learn as much as you can because it is a very rewarding experience and provides a joyous feeling to know you have played a vital role in the birth of one of God's treasured creatures. I sincerely hope that the words I have written will be of some help to anyone who wants to be a more successful bird breeder.

About The Author

John Klea is an instrumentation engineer working on the space shuttle main engine. He has 30 years of instrumentation and controls experience which he has used to modify incubators and enhance their performance. He has successfully hatched nearly all of the various species of exotic pheasants over the past 17 years. He is currently working with the tragopan pheasants and has had an excellent success record. He is always willing to lend a word of advice to those having incubation problems.●