Hypothermia, Also Called Cold-stun and Effects on Certain Species of Hummingbirds

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A brief history of hummingbirds and perches on feeders.
The oldest fossils of modern hummingbirds were found in Germany where they lived over 30 million years ago. Hummingbirds split from swifts and treeswifts around 42 million years ago, most likely in Eurasia, and then made it to South America about 22 million years ago, eventually coming to North America. In all that time, hummingbirds have been co-evolving with native flowering plants. Those flowers do not provide perches for the hummingbirds. The birds have for millions of years had to fly from flower to flower and of course, hover while feeding. Flying and hovering warms the hummingbirds and the small amount of nectar ingested from each flower on cold mornings and during cold cloudy days.

Even North America's small northern nesting hummingbirds, like Caliope Hummingbird (*Selasphorus calliope*), Black-chinned Hummingbird (*Archilochus alexandri*), Rufous Hummingbird (*Selasphorus rufus*) and Ruby-throated Hummingbird (*Archilochus colubris*) are able to survive fairly cold temperatures. However, maintaining their normal temperature of around 104 degrees F. depends on them being able to find enough insects and nectar on which to feed. How badly other hummingbirds are affected by hypothermia (cold-stun) from feeding on cold sugar water is unknown. Anna's Hummingbirds (*Calypte anna*) seem to be far less susceptible to cold than those listed above and have not been observed hypothermic even in winter.

Because of the millions of years that hummingbirds survived without feeding while perched on feeder perches, we know that perches are not necessary. Feeders were first made in the 1950s, and those first feeders did not have perches, so the birds had to hover while feeding. Providing a perch seemed like a kindness to the birds and also allows the human benefactor to more easily observe the perched birds. Because of consumer demand feeder manufacturers added perches to many of their feeders beginning in the 1970s and 1980s, with many feeder designs now available, most with perches.

Studies on hummingbird thermogenesis and hypothermia in hummingbirds. Providing perches is not based on the known biology of the hummingbirds. In fact, hummingbird thermogenesis studies such as the study done by Peng Chai et. al. (1998) in a hummingbird research laboratory in Texas shows that ingesting cold sugar water can result in symptoms of hypothermia, including inability to fly normally**.** (Chai P, Chang AC and Dudley R. 1998. Flight thermogenesis and energy conservation in hovering hummingbirds. The Journal of Experimental Biology, 201, 963–968)

An ornithologist and hummingbird researcher, Dr. Doug Altshuler, who worked with Dr. Chai and the other researchers on the Texas study, but was not a co-author, said in a phone conversation with Judy Hoy not long after the study was published, that what was found regarding the effects on ability to fly in the Texas study "was very concerning for hummingbird conservation." Both Douglas Altshuler and Robert Dudley have since done several enlightening studies concerning hummingbird flight, including one, which is somewhat pertinent to hovering versus perching**.** (Altshuler DL and Dudley R. 2003. Kinematics of hovering hummingbird flight along simulated and natural elevational gradients. Journal of Experimental Biology 2003 206: 3139-3147; doi: 10.1242/jeb.00540).

Another study that addresses the issue of thermogenesis in hummingbirds is by Lotz et. al. (2003). (Lotz CN, Martı´nez del Rio C and Nicolson SW. 2003. Hummingbirds pay a high cost for a warm drink. J Comp Physiol B (2003) 173: 455–462 DOI 10.1007/s00360-003-0346-8).

Most helpful, concerning the danger of hummingbirds becoming hypothermic, authors of an important recent study Geiser, et al. (2014) showed the difference between torpor and hypothermia. (Fritz Geiser, Shannon E. Currie, Kelly A. O'Shea, and Sara M. Hiebert. 2014. Torpor and hypothermia: reversed hysteresis of metabolic rate and body temperature. *Am J Physiol Regul Integr Comp Physiol* 307: R1324–R1329, 2014. First published September 24, 2014; doi:10.1152/ajpregu.00214.2014.)
https://pubmed.ncbi.nlm.nih.gov/25253085/

The authors strongly recommend using those terms correctly "in ways that are consistent with the underlying regulatory differences between these two physiological states**."** One of the authors, Dr. Sara M. Hiebert stated this to me in an email, "Hummingbirds don't need perches, and no native hummingbird plants in the New World provide perches for the birds that have fed on them for millions of years. Why, then, should we be providing perches on feeders? We can

actually help the birds by forcing them to hover while they feed. So why take this risk when it is not at all necessary and may be doing harm to the birds we are trying to help." See other comments by Dr. Hiebert and her answers to our questions concerning hummingbirds on page 5.

National Audubon Society's warning concerning what they call cold-stun. Another important warning concerning hummingbirds becoming hypothermic when feeding on cold sugar water is on the National Audubon Society's website on feeding hummingbirds, "Hummingbird Feeding FAQs." The hypothermic condition hummingbirds experience is referred to as "cold-stun" by National Audubon Society. They state this on their website.
https://www.audubon.org/news/hummingbird-feeding-faqs
"However, it's better not to have your hummingbirds drink very cold nectar; this can actually cold-stun them. For cold weather feeding, either bring the feeder indoors overnight when it gets cold and put it back outside first thing in the morning (hummingbirds need to feed as early as possible, especially when it's cold, to keep their energy up) or you can hang an incandescent light bulb near the feeder. These bulbs give off enough heat to keep the feeder warm."

Most often, feeders with perches are put up by people who are trying to help the hummingbirds. However, it appears that ingesting cold sugar water while remaining motionless on the perches found on many of the currently sold hummingbird feeders can cause the hypothermic condition National Audubon Society calls cold-stun. So to actually help the birds without endangering them, remove the perches or buy feeders that have no perches if you live in areas that frequently have day or night temperatures below 60 degrees. In areas that remain warm during the night so the sugar water does not become chilled to a temperature below 60 degrees, the perches likely do no harm and may help the birds by saving them from expending energy while feeding.

Comments by researchers of bird thermogenesis on why there should not be perches on hummingbird feeders where outdoor temperature can go below 60 degrees.

Dr. William A. Calder, Department of Ecology and Evolutionary Biology at the University of Arizona, Tuson, Arizona.
The late Dr. William A. Calder was the author of a 1994 study (Calder WA. (1994) When do hummingbirds use torpor in nature? Physiol Zool 67:1051–1076

http://www.jstor.org/stable/30163881) and many other important hummingbird studies. Dr. Calder was a famous ornithologist and hummingbird researcher. He explained the following in his letter to Bob and Judy Hoy when they wrote to him, inquiring about observations Bob Hoy made of hummingbirds that appeared to become hypothermic on feeder perches in 1983. The Hoys wanted to know what was wrong with the birds that tried to fly, but were not able to maintain normal flight and consequently went down onto the ground before reaching trees or bushes on which to land. One bird was found hanging upside down from a perch, similar to the one in the Google photo on page 10. Dr. Calder kindly wrote back in long hand (no email back then), explaining as follows concerning the problem with birds becoming too cold to fly when they drank very cold sugar water on cold mornings or on cold days.

"A consequence of lowered body temperature (hypothermia) is slowed responses and loss of motor functions and coordination. We humans cannot write or thread needles when our hands are very cold. Feeders are unnatural. In perhaps most cases, they do no harm, but just as I get a bellyache from drinking too much cold juice too rapidly, the rate at which a hummer can take in sugar water, and the amount (crop volume), if the fluid is very cold can cause a major temperature change in the bird's body. If 5/7 (body weight) of the bird has a normal body temperature of 104 degrees F., and the bird takes in 1/7 (of body weight) at 33 degrees F., and feathers (1/7 of the body mass) are not considered, the bird's body temperature would then be 92 degrees F., a 12-degree drop. Had this been complicated by the fact that the bird had not completely warmed up yet (beginning temperature less than 104 degrees F.), the bird would be even worse off. The heat produced by hovering (while feeding), somewhere between 5 and 10 times what is produced when perching, would offset the chilling effect."

Dr. Calder also said, "he had observed the hummingbirds that he and his colleagues had trapped and banded often had trouble flying when they were released after being given a big drink of cold sugar water immediately prior to being released."

Dr. Sara M. Hiebert Burch, Edward Hicks Magill Professor Emerita of Mathematics and Natural Science, Swarthmore College, Swarthmore, Pennsylvania.

With regard to the difference between torpor, hypothermia and sleep in hummingbirds, which should be of considerable interest to humming bird lovers, Dr. Sara M. Hiebert who was one of the authors of Geiser, et al. (2014) "Torpor

and hypothermia: reversed hysteresis of metabolic rate and body temperature." sent us the following explanation. "There is some disagreement about the definitions of these terms, but I would say the majority would agree with the following:"

"Torpor is a regulated hypometabolic reduced metabolism state. The key word here is "regulated." One of the ways to think about torpor is that the body temperature set point (the setting of its "thermostat") has been reset to a lower temperature (just as you would in your house at night, to conserve energy). When the bird is torpid, it has not stopped thermoregulating; rather, it is starting to defend a lower body temperature. Let's say that the torpid set point of a hummingbird is 50 ˚F. If the air temperature is higher than that, the bird will not produce any extra heat, but if the air temperature falls below 50 ˚F, it will generate just enough heat to keep its temperature at this new low set point, 50˚F. This means that the drop in body temperature and metabolic rate are not the direct result of running out of energy, though they may be a strategy that these birds can use to conserve energy when energy is in short supply. Just as the hypometabolic state is regulated, the expectation is that arousal from this state is regulated, and is part of a normal bout of torpor. "

"Hypothermia is, generally, simply a reduction in body temperature. But in the realm of torpor researchers, it is used by many to mean a pathological (as opposed to physiological) reduction in body temperature because the animal doesn't have the ability to maintain its body temperature setpoint. Its metabolic rate also decreases, but because it has run out of energy or is otherwise unable to generate sufficient heat. By this definition, hypothermia is unregulated, and without some external interference (e.g., warming of the environment or by someone's warm hands), an animal may be unable to rewarm. This is the sense in which I use the term "hypothermia." I have not generally heard the term "cold-stun," but my interpretation is that it would be a case of what I refer to as hypothermia."

"Sleep is a specific physiological state defined by the pattern of brain activity shown in an electroencephalogram (EEG). This is why it is difficult to say definitively that an animal at rest is sleeping simply by observing its behavior."

"To determine whether a bird has entered torpor or is undergoing hypothermia, one needs to know more than the body temperature, since it would decrease in both torpor and hypothermia. Knowing a combination of body temperature and simultaneously measured metabolic rate, however, can help us to distinguish

between these two states, as Fritz Geiser and I showed in a recent paper (Geiser et al. (2014), referenced on page 2). Sleep, similarly, would technically require an EEG, but could be surmised if body temperature was at a normal resting (as opposed to torpid) level and the bird could quickly wake up when disturbed."

Dr. Hiebert also sent us the following in response to our questions concerning observed adverse affects in hummingbirds.

Hi Judy and Bob,

Thanks for your interesting message and your questions. You are not the first to ask!

I thought your hypothesis about what was going on with birds at feeders in early morning and the solution you arrived at showed good problem solving skills. It does make sense to me, and supports the idea that the birds are hypothermic, not torpid or asleep if they become unresponsive while on a perch.

- Here are my responses to your questions
  - When I talked to ornithologists about torpor and that unresponsive condition my husband, Bob and I called "perch hypothermia" all said that hummingbirds do not suddenly go into torpor, especially in the daytime. Is that still what ornithologists know to be true?
    I would agree.
  - Did you or your colleagues ever do a study showing that hummingbirds do go into torpor suddenly in the daytime to conserve energy, even on sunny days?
    I know of no study that shows the birds doing this under natural conditions and a normal light-dark cycle. Under natural alternation of light and dark, torpor appears to be regulated by a combination of seasonal state, time of night, energy level, and time remaining until the birds can feed again.
  - If the birds are said to be in "torpor" in the daytime, they aren't actually "sleeping" are they (like some of the websites now say)?
    Although the evidence we have says that torpor is entered from a state of slow-wave sleep, sleep and torpor are not equivalent physiological states. The problem for measuring sleep is 1) that EEGs are hard to get from hummingbirds and 2) the EEGs of torpid animals tend to disappear because brain activity at low body temperatures is so diminished. The evidence suggests to me that

birds that are cold and immobile during the day are likely hypothermic, not torpid or sleeping.

- When the birds are unresponsive on the feeder perch, right side up or hanging upside down or sitting unresponsive on the ground, do researchers consider this condition safe for the birds, whether they are actually in torpor or sleeping or hypothermic (like we concluded in 1983 and since)?
  I do not consider this a safe condition for birds. In my experience, a bird that becomes unresponsive during the day is a bird that has run out of energy and, without intervention (such as passive warming and feeding), will likely die. My experience also shows that even if a bird in this condition can be revived and fed, it may never return to normal behavior and may ultimately die. My observations were not made in cases where birds ingested cold nectar and suddenly became hypothermic because of the cold load, however. Under these conditions, if the birds can warm up again, they might survive; I have no personal experience to support this conjecture, however.

Dr. Bret Tobalske, University of Montana, Professor, Director of the Field Research Station, University of Montana, Missoula MT.
Dr. Tobalske suggested that unresponsive birds, especially those hanging upside down from perches or branches or lying on the ground are usually close to death from hypothermia or starvation, possibly a combination of both. Dr. Tobalske also stated "---that habitat degradation, direct loss and pollution with pesticides (especially Imidacloprid in the case of birds) are much greater problems, but not nearly as easy to mitigate. Removing a few pieces of plastic from a hummingbird feeder is the easiest fix ever for an environmental problem completely caused by humans."

- Here are my responses to your questions
  - When I talked to ornithologists about torpor and that unresponsive condition my husband, Bob and I called "perch hypothermia" all said that hummingbirds do not suddenly go into torpor, especially in the daytime. Is that still what ornithologists know to be true?
    That is also my impression. Torpor takes a "settle down" interval, and my impression is that when the birds are stressed for any reason in the daytime, they do not spontaneously go into torpor. I have had captive birds stop eating, stressed males, and they do things like

hang upside down or lay on the floor of their cage. They are motionless, but not in torpor. They are near death.

- Did you or your colleagues ever do a study showing that hummingbirds do go into torpor suddenly in the daytime to conserve energy, even on sunny days?
  No
- If the birds are in torpor in the daytime, they aren't actually "sleeping" are they (like some of the websites now say)?
  True, torpor is not sleeping. Torpor is a reduced state.
- When the birds are unresponsive on the feeder perch, right side up or hanging upside down or sitting unresponsive on the ground, isn't this condition considered unsafe for the birds?
  Yes, it is highly unsafe. As I wrote above, my impression is that they are near death.
- Are the birds that suddenly become unresponsive, hang upside down from the perch or fall to the ground actually in torpor as some say, are they just sleeping as others say, or are they actually hypothermic or cold-stunned, National Audubon Society's term for hypothermia on their website about feeding hummingbirds indicates?
  They may be hypothermic, or they may be starving.

Dr. Jack Kirkley, Professor of Biology Western Montana College, Dillon, Montana.

What Jack Kirkley, who studied thermogenesis of other birds, but not hummingbirds stated regarding this issue is summarized as follows.

Most often feeders with perches are put up by people trying to help the hummingbirds. However, it appears that ingesting cold sugar water while remaining motionless on the perches found on many of the currently sold hummingbird feeders can cause the hypothermic condition National Audubon Society calls cold-stun. So to actually help the birds without endangering them, the perches should be removed. Or people can buy feeders to put up that have no perches, especially in areas that frequently have cold day or night temperatures. In areas that remain warm during the night so the sugar water does not become chilled, the perches likely do no harm and may help the birds by saving them from expending energy while feeding.

He also said “It might be wise for bird lovers to advocate for "revolutionizing" the hummingbird feeder industry... leading either to an immediate ban of perches on hummingbird feeders, or at least asking manufacturers to have easily removable perches for those folks who put out feeders in regions where cold-stun (hypothermia) might be a problem. There should be warnings placed on the hummingbird feeders about the risk of cold-stun and the advisability of taking the feeder inside overnight. A relevant quote from the National Audubon Society could give that recommendation a degree of "authority".

Additionally, both Bret Tobalske and Jack Kirkley agreed that ideally, all perches could and should be removed from the feeders that people already own and use in areas that have cold temperatures at night or during the day, before the feeders are used again. If it is not possible to remove the perches from certain feeders because of the way they are made, the sugar water can be warmed during cold periods as suggested by National Audubon Society’s Hummingbird Feeding FAQs website. However, if the suggested warming is not possible, hummingbird lovers could purchase at least one feeder that has no perches to leave out over night so the hummingbirds have to fly and hover while feeding in early morning. That way the birds can ingest the possibly life saving sugar water, without being endangered by hypothermia.

Discussion of photos of hummingbirds affected by hypothermia/cold-stun.
“Cold-stun” in hummingbird species was called “hypothermia” or “perch hypothermia” by Bob and Judy Hoy in 1983, long before discovering that it is currently being referred to by other terms. Some terms used on the Internet are “cold-stun” or cold-shock and even “daytime torpor” or “sleep.” As stated by Dr. Sara M. Hiebert and Dr. Brett Tobalske, torpor, sleep and hypothermia are completely different conditions. If you put the following link on Google search you can see many photos of hummingbirds experiencing hypothermia. The number of hummingbirds, which definitely appeared to be hypothermic in the posted photos was over 30. An example is the bird in the photo on page 10. People who posted the photos often labeled the documented condition incorrectly.
https://www.google.com/search?q=hummingbirds+in+torpor+images&sxsrf=ALeKk00sLny_tgOmLoBX017-GqMC-pOacw:1615148566958&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjP7d6kgZ_vAhVQip4KHYssAfsQ_AUoAXoECBsQAw&cshid=1615148575602190&biw=1119&bih=851

Another website (https://www.lehighvalleylive.com/sports/2013/07/hummingbirds_utilize_torpor_to.html) stated the following, “But in recent years, with the proliferation of backyard feeders, observations of birds hanging motionless upside down at odd times have been reported quite often, and the only explanation that experts to date have come up with is that, for reasons unknown, they do it on purpose. So if you see one like this, let it alone. It will probably recover on its own without your help. Resist the urge to do anything unless it falls to the ground, which means there may really be something wrong with it. But even then, wait to see what happens. It may still recover and fly off. Hummingbirds are amazing creatures, but there are still a lot of things they do that biologists haven't yet figured out.” Most of this information concerning affected birds, unfortunately for those birds, is completely incorrect. The birds are hypothermic and should be carefully removed from the perch, warmed by holding them, while blowing warm air on them until they have recovered and can fly, and then be released. Please remove all perches from feeders so this does not happen to the hummingbirds. It can cause mortality.

This cold-stunned hummingbird posted on the Internet was obviously affected during the daytime, and thus according to Dr. Sara Hiebert Burch and Dr. Bret Tobalske was hypothermic, not in torpor or sleeping as some who posted such photos on the Internet suggested. A bird in this condition is in grave danger and even greater danger if it falls to the ground.

As the hummingbird researchers quoted herein state, the cold unresponsive birds are definitely not sleeping nor are they in torpor. One important consideration is that being unresponsive and unable to fly or respond to dangers because of hypothermia, can result in the death of the affected hummingbird. Also as two of the recently contacted hummingbird researchers stated, unresponsive hummingbirds may be near death, especially if they are lying on the ground. If the bird tries to fly off of the perch and ends up on the ground, it is highly susceptible to being caught by predators or to dying of starvation. Predators include cats, dogs, corvids, birds of prey, members of the weasel family, other predators, and deer. Yes, deer, at least white-tailed deer, have been documented with video, catching and eating a flightless bird.

Even if the bird remains on the perch right side up or hanging upside down, a female hummingbird that remains in that condition for a fairly long period of time would not be able to return to her nest to protect her eggs or hatchlings from being killed by cold and/or starvation.

If the birds were in actual torpor, they would take much longer to recover than the hummingbirds that are what National Audubon Society calls cold-stunned. Ornithologists consulted have said that hummingbirds go into torpor at night when they are well hidden, and only if they need to conserve energy. It takes some time for a hummingbird to deliberately become torpid. In the morning, when the bird shivers to bring itself out of torpor, it takes anywhere from 20 minutes to an hour for a hummingbird to fully recover from an actual torpor condition. (Hiebert S (1990) Energy costs and temporal organization of torpor in the rufous hummingbird (Selasphorus rufus). Physiological Zoology 63:1082-1087).
https://www.journals.uchicago.edu/doi/abs/10.1086/physzool.63.6.30152634

If warmed soon after becoming hypothermic, hummingbirds experiencing hypothermia/cold-stun, recover quickly, in 10 to 15 minutes at which time they can fly normally and appear to be healthy. Hummingbirds can also be cold-stunned very quickly, in just 10 minutes or even less if they are consuming very cold sugar water while remaining motionless. (See the description of the tests done on two flightless Rufous Hummingbirds on page 12.)

In the past, many people insisted that hummingbirds couldn't become hypothermic because of ingesting cold sugar water while perched. Consequently, it was impossible to get this issue universally addressed. With the new studies of hummingbird thermogenesis and the astute statements by multiple hummingbird

researchers, it may finally be possible to get something done to prevent hummingbirds from being harmed or killed by hypothermia/cold-stun.

The effects of pesticides on the metabolism of hummingbirds.
Another consideration is the effects of insecticides like Imidacloprid on insect eating birds. Imidacloprid is an insecticide that has been shown to kill many species of invertebrates, particularly arachnids and most species of beneficial insects. Imidacloprid also internal organ damage on vertebrates, including mammals, such as white-tailed deer, other wild ungulates, domestic livestock and pets. Imidacloprid has been found to be especially deadly to birds. Besides causing neurological damage and/or mortality to the adult birds, it kills most of the non-target insects most hatchlings need to be fed for normal growth. Also, a lack of spider webs hummingbirds eat for protein and use to build their nests would likely be a detrimental factor for hummingbirds connected with excessive Imidacloprid use. Another especially concerning issue for hummingbirds, Imidacloprid kills the insect pollinators that pollinate the flowering plants the birds need for nectar. The reference for a recent study about hummingbirds, insect pollinators and Imidacloprid is (Bishop CA, Woundneh MB, Maisonneuve F, Common J, Elliott JE, Moran AJ. Determination of neonicotinoids and butenolide residues in avian and insect pollinators and their ambient environment in Western Canada (2017, 2018). Sci Total Environ. 2020 Oct 1;737:139386. doi: 10.1016/j.scitotenv.2020.139386. Epub 2020 May 26. PMID: 32563110.)
https://pubmed.ncbi.nlm.nih.gov/32563110/

The following link is to an interesting article about the above study.
https://ornithologyexchange.org/forums/topic/34057-decline-in-hummingbird-population-linked-to-insecticide/

A Hypothermia experiment done on two unreleasable Rufous Hummingbirds.

The same experiment was done by Judy Hoy in two different years with two unreleasable Rufous Hummingbirds that proved hypothermia occurred after cold sugar water was ingested only twice, while the bird was sitting motionless in cold (near 45 degree F.) outdoor conditions. This caused both birds to quickly become unresponsive and have to be warmed.

Neither of the birds on which the experiment was done could fly because they had one wing badly damaged by a cat. Both eventually had to be euthanized

when it became evident they would never fly again. The experiment on the first bird was in 1997 and then repeated on a second permanently injured bird in 1998. This was to make certain the behaviors observed on the first bird were unequivocally caused by the cold sugar water and were not because of some kind of adverse health issue.

Everything was done the same with both birds, with the sugar water and the outside temperature as close to the same temperature as possible. For both trials, the hummingbird was outside on a cool, cloudy day when the air temperature was between forty and forty-six degrees Fahrenheit. The bird was placed on a low branch of a bush, so if it fell, it would not get hurt. After just one drink of forty-five degree sugar water, the hummingbird's feathers quickly fluffed up and it became quite lethargic. In both trials, the bird ceased to look around or pay attention to its surroundings after the first drink of cold fluid. They sat motionless with their bills pointed upward. In ten minutes, the bird was allowed to drink the cold sugar water again. After drinking the second time, both birds became completely unresponsive and didn't move even if touched. In both trials, as soon as the bird became obviously hypothermic and didn't respond to movement, sound or being touched, it was taken inside to be warmed on a heating pad.

Obviously, it was important to determine if the affected hummingbird could recover to normal behavior after being warmed. With both birds, it took nearly fifteen minutes of sitting on a warm cloth over a heating pad in its box before it warmed enough to resume normal behavior. After each bird had warmed, it fluttered up onto low branch and began to preen its feathers. After preening, the bird went to the feeder in its box to feed as usual from a syringe containing sugar water, which was approximately seventy-nine degrees.

After two hours inside to make certain the bird had completely recovered, it was again taken outside and put it on the low bush. When the hummingbird being tested wanted to feed, it was allowed to drink from the syringe filled with cold forty-five degree sugar water. Immediately after drinking the cold sugar water, the bird's feathers fluffed up and it pointed its bill upwards, becoming much less alert and fairly unresponsive. As in the first test, after the second drink, the bird became completely unresponsive and had to be taken inside and again placed on the heating pad to warm it.

After each bird had recovered and was acting normally, it was taken to the branch outside for a different experiment. For this test, the birds were allowed to drink

When a lively, healthy, but permanently flightless Rufous Hummingbird was given cold sugar water to drink while sitting motionless on a branch on a cool cloudy day with a 45 degree outside temperature, it fluffed up its feathers and quickly became hypothermic and completely unresponsive to stimuli.

whenever they wanted from a syringe of warm eighty-degree sugar water. After drinking the warm sugar water the bird's behavior remained completely normal even after several drinks and over a half hour sitting in the cold outside air temperature. Neither of the birds fluffed their feathers and both continued to look around at the wild birds and other things of interest to them. After each had fed six times on warm sugar water with no observable adverse affect, it was returned to its box in the house.

Results:
The results of the three experiments with two different hummingbirds in different years were the same. The birds became cold, with feathers fluffed and each was completely unresponsive after just two drinks of the cold 45 degree F. sugar water, which was close to the same temperature as the outside air temperature. Both birds were kept for over a week after the tests to be certain there were no adverse affects from the experiments or a health problem that might have affected their behavior during the experiments.

The purpose of the second experiment with warm sugar water was to determine if there was an adverse affect on the birds if the sugar water is warm when they ingest it in cold outdoor temperatures, as National Audubon Society suggests. That test showed when the birds ingest warm sugar water while remaining motionless, it did not result in them having hypothermia or any other visible adverse affects.

The purpose of doing the same experiment with the two flightless, but otherwise healthy hummingbirds was to determine whether a hummingbird actually would become hypothermic if it remained quietly sitting on a perch while drinking more than one cropful of cold sugar water. That test showed that the birds definitely did become hypothermic after ingesting just two drinks of cold sugar water in cold outdoor temperatures while remaining motionless as they often do on a feeder perch.

Final Thoughts Concerning Hypothermia and Hummingbirds, especially Rufous Hummingbirds.
Every year, the Rufous Hummingbird, which weighs just 3 grams makes one of the longest migratory journeys of any bird close to its size, flying up to 3,900 miles from its winter home in Mexico to the northern United States and

Canada, where they nest. The Rufous Hummingbird has lost 62% of its population between 1966 and 2014, recently declining at a rate of 3% per year. At that rate, they will soon be endangered. Habitat loss, climate change, pesticides like Imidacloprid and fragmentation of breeding grounds are the most often mentioned causes.

People in many states have observed individuals of various species of hummingbirds, particularly Rufous and Ruby-throated, that fell directly to the ground completely hypothermic or tipped over to hang upside down from the feeder perch. Some flutter frantically just above the ground, then go down to the ground because their wings do not work properly. Being hypothermic until the sun warms the bird so it can fly prevents some females from returning to the nest in a timely manner or in some cases result in the mother bird's death. If that is happening, the consequent nesting failures may be contributing to the declines in affected hummingbird populations.

Unfortunately, at this time, no formal studies have been done to show how many hummingbirds are being adversely affected or possibly killed by becoming hypothermic on feeders with perches. Thus, studies on this issue need to be done as soon as possible to quantify hummingbird mortality. Whether there are enough birds killed by hypothermia and subsequent starvation to affect hummingbird populations is unknown at present.

Also, an important consideration is that each species of hummingbird has somewhat different thermodynamics, as does each individual bird, depending upon its condition and whether it has been exposed to hormone disrupting environmental toxins such as Imidacloprid, glyphosate, 2,4-D, other pesticides and toxins in nectar or to plastic in drinking water. Such possible exposures does not justify causing the susceptible birds to incur an unnecessary premature death or serious injury as a result of feeding while perched. This is especially true if the main reason for having perches on feeders is to make the birds easier for people to see. Providing hummingbirds with supplementary food in feeders is supposed to help the birds, especially when nectar from natural flowers are in limited supply or while the adults and juveniles are fattening up for their long migration.

Under the Migratory Bird Treaty Act of 1918, killing migratory birds such as hummingbirds has been illegal for over 100 years. If the scientific method had been followed, feeders with perches definitely should have been tested to determine if they were a danger to individuals of any species of hummingbird PRIOR to making and selling them to millions of people over the last 50 years.

Since hummingbirds have been protected since 1918, devices responsible for migratory bird deaths have always been and still are illegal to manufacture and use.

If the birds have to hover while ingesting the cold fluid and fly from their favorite tree branch to the feeder and back to the branch, the effort of flying helps to warm the cold fluid the bird ingests. Flying from the tree branch and back and hovering while drinking appears to prevent the dangerous hypothermia/cold-stun condition from happening. Also, the birds appear to ingest somewhat less of the cold fluid while hovering than when perched.

Until more definitive studies on hypothermia/cold-stun in hummingbirds can be done, using only feeders without perches in areas having daytime temperatures below 60 degrees and nighttime temperatures far lower is an easy fix to an environmental issue that may be very serious. In areas with cool temperatures, please use only feeders without perches unless you continuously warm the sugar water as suggested by the National Audubon Society website "Hummingbird Feeding FAQs." https://www.audubon.org/news/hummingbird-feeding-faqs

Finally, a warning to not believe websites on the Internet that say that hummingbirds can't become hypothermic. Obviously, the studies that have been done on hummingbird thermogenesis show they can. The cautionary statements in this document provided by very knowledgeable researchers show definite cause for using only perchless feeders to prevent harm and possible mortality to hummingbirds. Attracting hummingbirds by supplemental feeding can provide many hours of enjoyable hummingbird watching, and can be beneficial to the hummingbirds if the welfare of the birds is always the primary consideration.

Thank you for your concern for hummingbirds.

For more on effects on wildlife by exposure to neonicotinoids like Imidaloprid and herbicides such as Roundup, 2,4-D and others, go to my website (www.judyhoy.com) and scroll down to near the bottom, to PDFs to Download. Click on that and then click on various photo documents showing mammals or birds with birth defects and other adverse health effects caused by exposure to toxins during development. Also, click on the published studies that were done on animals, wild and domestic, shown to have those

and other adverse health issues. Additionally, More Concerning Issues has several articles about wildlife, humans, pesticide effects on both, and other information.