"Behavioral Thermoregulation by Turtle Embryos" (2011), by Wei-Guo Du, Bo Zhao, Ye Chen, and Richard Shine [1]

By: Moeller, Karla Keywords: Turtles [2] Environment [3]

"Behavioral Thermoregulation by Turtle Embryos" (2011), by Wei-Guo Du, Bo Zhao, Ye Chen, and Richard Shine

In "Behavioral Thermoregulation by Turtle Embryos," published in *Proceedings of the National Academy of Sciences* [4] in April, 2011, Wei-Guo Du, Bo Zhao, Ye Chen, and Richard Shine report that turtle embryos can move towards warmer temperatures within the egg [5] when presented with a small, 0.8 degrees Celsius gradient. This behavioral thermoregulation may benefit the embryo's fitness by accelerating the rate of development enough to decrease the incubation period by up to four and a half days. Embryos are generally thought to have little control over their surroundings. This study revealed that embryos may be able to control their developmental environment by modifying their behavior.

Du is a professor at the Institute of Zoology in the Chinese Academy of Sciences in Beijing, China. From 2003 to 2004, and then again from 2007 to 2010, Du held a postdoctoral appointment with Shine at the University of Sydney in Sydney, Australia, where Shine is a professor of evolutionary biology. Bo Zhao and Ye Chen are Du's collaborators at Hangzhou Normal University in Hangzhou, China, where Du held a professorship from 2005 to 2006. In his research program, Du seeks to understand the causes of phenotypic variation, with a focus on thermal adaptation in embryos

Using Chinese soft-shelled turtles [6] (*Pelodiscus sinensis*), Du and team conducted laboratory experiments in the Key Laboratory of Animal Ecology and Conservation Biology at the Chinese Academy of Sciences in Beijing, and they conducted field experiments in eastern China. In the laboratory, eggs from a commercial turtle farm were individually housed in jars. The embryos' starting locations within the eggs were determined using candling, a method in which the scientist shines light through an egg [5], allowing a rough observation of the egg's contents. The researchers removed portions of the eggs' shells to measure each embryo's midpoint location, which the scientists defined as the position in the egg [5] where the embryo's neck meets the top portion of the developing shell. This measure was used throughout the experiment to measure total movements.

The embryos incubated in the lab were split into two treatment groups based on the location of the heat source—either directed to the top or to the side of the jar. Heat was delivered to the jars using heat mats, maintaining close to optimal incubation temperature of 28 degrees Celsius within the eggs. To record the range of temperatures available to the embryos, the researchers monitored temperatures at three points on the surfaces of twenty eggs from the top-heat treatment. The researchers used the other eggs in the top-heat treatment as a control to monitor embryo movement when the heat source remained in a constant position. In the side-heat treatment, the scientists switched the heat source to the opposite side of the jars after fifteen days of a twenty-seven day trial. The researchers removed a portion of the eggs in each treatment and dissected every three days to measure the angle of deviation from original measurements.

When laying eggs, soft-shelled turtles [7] in eastern China dig nests near riverbanks, with the highest egg [5] laid six to eleven centimeters deep. In the field thermoregulation experiments, the scientists incubated the eggs in thirty-six man-made nests that simulated these wild nests. The researchers made nests either on flat ground or on a steep slope, so that heat from the sun was reaching the eggs from the top, or the side, respectively. In flat nests, scientists buried the eggs with embryos at the top of the egg [5]. Scientists split eggs in the slope nests into two groups, one with the embryos at the top of the eggs, and the other with the embryos as far from the sloped soil surface as possible.

Both laboratory and field heat-source treatments showed that the embryos moved within the eggs to track a heat source. In the lab, embryos with a side-heat source wound up positioned in a significantly different part of the egg [5] than the top-heated group. Additionally, when scientists moved the heat source, embryos tracked the heat source until they ended up positioned in the new warmest part of the egg [5]. In the field, embryos either remained at the location in the egg [5] nearest the sun-heated soil or moved towards that location.

These results support the hypothesis that at least one species of soft-shelled turtle embryos behaviorally thermoregulate. Although all results supported this hypothesis, side-heated laboratory embryos took up to seven days to move 180 degrees in the egg [5] to track the heat source. Thus, the ability for accelerated development that the authors propose would depend heavily on how quickly embryos can move within their shells.

Du's work with his colleagues on embryo behavior received attention from popular science publications, including *Discover magazine* blog *Not Exactly Rocket Science.* Until this point, many have viewed embryos as helpless entities, unable to change the route of their own development. Embryonic thermoregulatory behavior indicates that embryos may be able to influence their own development time and developmental temperature, with the potential for sex ratio effects in species with temperature-dependent sex determination [8].

Sources

1. Du, Wei-Guo, Zhao, Bo, Chen, Ye, and Richard Shine. "Behavioral Thermoregulation by Turtle Embryos." *Proceedings of the National Academy of Sciences* [4] 108 (2011): 9513–5.
2. Duca, Edward. "Animal Behavior: Soaking up the Heat." *Nature China* July, 2011. Doi: 10.1038/nchina.2011.48. http://www.nature.com/nchina/2011/110706/full/nchina.2011.48.html [9] (Accessed Septemeber 20, 2012).
3. Le Moine, Chris. "Some Eggs Like it Hot." *The Journal of Experimental Biology* 124 (2011): iv–v.
4. Yong, Ed. "Turtle Embryos Bask Against the Warmest Side of Their Eggs." *Discover Magazine* Blog: *Not Exactly Rocket Science*. May 21, 2011. http://blogs.discovermagazine.com/notrocketscience/2011/05/23/turtle-embryos-bask-against-the-warmest-side-of-their-own-eggs/ [10] (Accessed September 20, 2012).

In "Behavioral Thermoregulation by Turtle Embryos," published in Proceedings of the National Academy of Sciences in April, 2011, Wei-Guo Du, Bo Zhao, Ye Chen, and Richard Shine report that turtle embryos can move towards warmer temperatures within the egg when presented with a small, 0.8 degrees Celsius gradient. This behavioral thermoregulation may benefit the embryo's fitness by accelerating the rate of development enough to decrease the incubation period by up to four and a half days. Embryos are generally thought to have little control over their surroundings. This study revealed that embryos may be able to control their developmental environment by modifying their behavior.

Subject

Embryos [11] Body temperature--Regulation [12] Turtles [13] Evolutionary developmental biology [14] Evolution (Biology) [15] [16] Adaptation (Biology) [17] Animal behavior [18] Reptiles--Eggs [19] Turtles [20]

Topic

Publications [21]

Publisher

Arizona State University. School of Life Sciences. Center for Biology and Society. Embryo Project Encyclopedia.

Rights

Format

Articles [22]

Last Modified

Wednesday, July 4, 2018 - 04:40

DC Date Accessioned

Monday, November 5, 2012 - 19:10

DC Date Available

Monday, November 5, 2012 - 19:10

DC Date Created

2012-09-20

DC Date Created Standard

Thursday, September 20, 2012 - 07:00

- [Contact Us]

- The Embryo Project at Arizona State University, 1711 South Rural Road, Tempe Arizona 85287, United States

---

Source URL: https://embryo.asu.edu/pages/behavioral-thermoregulation-turtle-embryos-2011-wei-guo-du-bo-zhao-ye-chen-and-richard-shine

Links
[1] https://embryo.asu.edu/pages/behavioral-thermoregulation-turtle-embryos-2011-wei-guo-du-bo-zhao-ye-chen-and-richard-shine
[2] https://embryo.asu.edu/keywords/turtles
[3] https://embryo.asu.edu/keywords/environment
[4] https://embryo.asu.edu/search?text=National%20Academy%20of%20Sciences
[5] https://embryo.asu.edu/search?text=egg
[6] http://eol.org/pages/791178/overview
[7] https://embryo.asu.edu/search?text=turtles
[8] https://embryo.asu.edu/search?text=sex%20determination
[9] http://www.nature.com/nchina/2011/110706/full/nchina.2011.48.html
[10] http://blogs.discovermagazine.com/notrocketscience/2011/05/23/turtle-embryos-bask-against-the-warmest-side-of-their-own-eggs/
[11] https://embryo.asu.edu/library-congress-subject-headings/embryos
[12] https://embryo.asu.edu/library-congress-subject-headings/body-temperature-regulation
[13] https://embryo.asu.edu/library-congress-subject-headings/turtles
[14] https://embryo.asu.edu/library-congress-subject-headings/evolutionary-developmental-biology
[15] https://embryo.asu.edu/library-congress-subject-headings/evolution-biology
[16] https://embryo.asu.edu/taxonomy/term/3036
[17] https://embryo.asu.edu/library-congress-subject-headings/adaptation-biology
[18] https://embryo.asu.edu/library-congress-subject-headings/animal-behavior
[19] https://embryo.asu.edu/library-congress-subject-headings/reptiles-eggs
[20] https://embryo.asu.edu/medical-subject-headings/turtles
[21] https://embryo.asu.edu/topics/publications
[22] https://embryo.asu.edu/formats/articles