

Chaos and the Monarch Butterfly

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Abstract. The migration of the monarch butterfly is considered from the perspective of chaos theory, and compared to the evolution of human culture.

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1. Introduction.

From a simple life as a tropical insect two million years ago, the monarch has evolved one of the most wonderful of nature's phenomena: the monarch migration. We may recount the story of this wonder briefly by following a colony for one year, beginning in the spring, after the winter rest in a special clump of trees high on a mountain top in Mexico. (See Figure 1.)

- Step 1. Awake, it is spring in Mexico.
- Step 2. Fly 2500 miles north to a favorite summer spot, rich with milkweed fields, in southern Canada.
- Step 3. Summer spectacular, sex and reproduction among the milkweeds.
- Step 4. All change, it is fall in Canada.
- Step 5. Fly south back to the same grove in Mexico.

We might think of this as a day in the life of a monarch colony: wake-up in the morning, go out to play hard all day long, back to bed in the evening when it gets cold. However, it is a year, and many miracles, long. We will focus now on just one of these miracles: Between the monarch that wakes up in the Spring and the one that goes to sleep in the Fall are several generations! Where do they store the road map back to the bedroom?

2. The microcosmic model.

Proceeding further with the day-in-the-life analogy, imagine that I awake one morning, fly to Canada, spend the day picking milkweeds, then fly home in the evening. The return journey is a replay of the morning flight in reverse, and my memory of landmarks along the way guide me home. Tired after a 12-hour journey, I go to sleep. Nothing unusual.

However, if I am a monarch colony speeded-up by a factor of 360, then with each hour or two of daylight I have died and been replaced by a child. Furthermore, during my early life I am a caterpillar, and later a butterfly, and in between I have a total meltdown. (See Figure 2.) During all of these life bifurcations, where is my memory of the way home? Sheldrake proposes a morphic field as the storage medium for this knowledge. We might further propose a mathematical model for this field based on chaos theory, that is, a complex dynamical model for a morphic field that functions as a mental field with memory for a colony. In fact, we have already written about such a model in another context, that of the prehistory and history of the human colony on planet Earth, in the book, *Chaos, Gaia, Eros*.

3. The macrocosmic model.

Now we consider the monarch summer journey as a model not of a day in my life, but of an epoch of human history. The wake-up in the Spring is the creation, told in so many ways in the creation myths of tribes of all times and places. The journey North is the development phase of culture, including stone industries, calendrical and astronomical math, languages, and so on, up until the development of agriculture. The summer among the milkweeds is the garden of Eden, before the present realization that the environment is finite. And now we must find our way home. But after all these bifurcations, where is our map? Perhaps we have lost our connection to our own morphic fields, and must follow the butterflies. Unfortunately, they are facing extinction.

4. Mathematical foundations of morphum mechanics

Yes, this section title is a paraphrase of the great classic, *Mathematical Foundations of Quantum Mechanics*, by John von Neumann (Princeton University, 1955). When this book first came out, it

was chosen as a text by one of my professors at the University of Michigan, Erich Rothe. This wonderful book and memorable professor played a pivotal role in my love affair with mathematics and early career. Focussing on the mathematical model for the quantum field, one is not distracted by the formidable question: just what is a quantum field? Proceeding in this fashion with the morphic field, with Peter Broadwell, I created a global-analytic model for the morphic field connecting a dog and her owner, and again for a flock of birds.

Global analysis is a branch of mathematics which emerged during the first half of this century. Its project was to rewrite about half of mathematics as a special case of dynamical systems theory, or chaos theory. In particular, the functions of mathematical physics, such as the fields or states of quantum mechanics, were regarded as infinite-dimensional vectors, and the partial differential equations of mathematical physics — such as the wave equation of d'Alembert, the heat equation of Fourier, the Maxwell equations for the electromagnetic field, and the Schroedinger equation of quantum theory — were considered vectorfields (dynamical systems) on the infinite-dimensional state spaces. This ambitious project resulted in a global unification of mathematics and mathematical physics, without clarifying in any way the real natures of the fields, forces, and mechanics of physical nature.

When the fields and equations of physics are transformed into chaos theory, and then prepared as computer programs for computational studies, the infinite dimensional systems are approximated by finite (but high) dimensional systems of the sort known to the theories of chaos, bifurcations, and complexity as *cellular dynamical systems*. And this is the approach taken by Peter Broadwell and myself in modeling the morphic field of a fish school or bird flock. In fact, we chose the wave equation as the mathematical foundation for our morphic field models, and thus the models tended to vibrate wildly. We taught our model birds to modulate and demodulate this vibrating field to communicate with each other. And this is the sort of model I am now proposing for a colony of monarch butterflies.

We may think of the ensemble of monarchs has little motors maintaining a state of continuous vibration in their collective field. When one dies and another is born — these are bifurcations — the field is only slightly affected. The cognitive map of the colony (including the directions for finding the way home) is maintained in the collective field as a chaotic attractor.

5. Conclusion.

The phenomenon of the monarch migration is miraculous, and unexplained by modern science. For hundreds of thousands or even millions of years they have thrived, repeating their annual miracles, thanks to apparently paranormal powers. We must follow the monarchs into the morphic field, or into extinction. Chaos theory is just one strategy for reconnecting with morphic fields and the wisdom of nature. Adopting the monarch migration as a model for the entire trajectory of the human race, we are led to the idea that even though as individuals we know not where we are going nor from whence we came, we may nevertheless be en route, if we can maintain resonance with our collective morphic field. And mathematics may be a strategy for maintaining that resonance.

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end: monarch



Figure 1. Paths of fall migrations. Western colonies (west of the Rocky Mountains) fly west to the California coast. Eastern colonies fly a longer route to Mexico. From (Grace, 1997, p. 48). Source (Brower, 1995, p. 322). See also (Brower, 1996, p. 95).

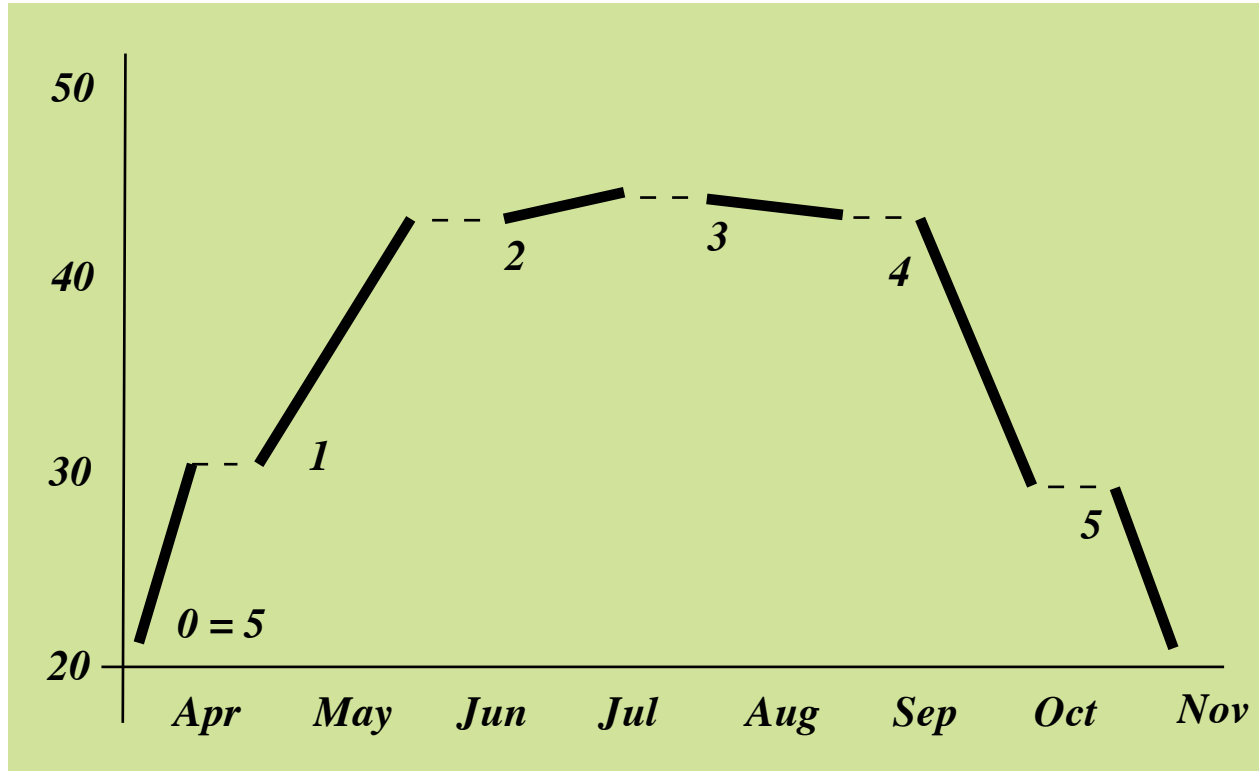


Figure 2. A histomap showing 8 months in the life of an eastern colony of monarch butterflies. Dashed lines indicate the caterpillar phase, and solid lines the butterfly stage, of each generation. Numbers count the generations. When butterfly 5 goes to sleep in Mexico in mid-November, it is the same butterfly, now counted as 0, which awakes in mid-March.

Latitude is indicated on the vertical axis, from 20 degrees North (Mexico City, bottom) to 50 degrees North (Southern Canada, top). Time runs along the horizontal axis to the right, for 8 months, beginning in mid-March..

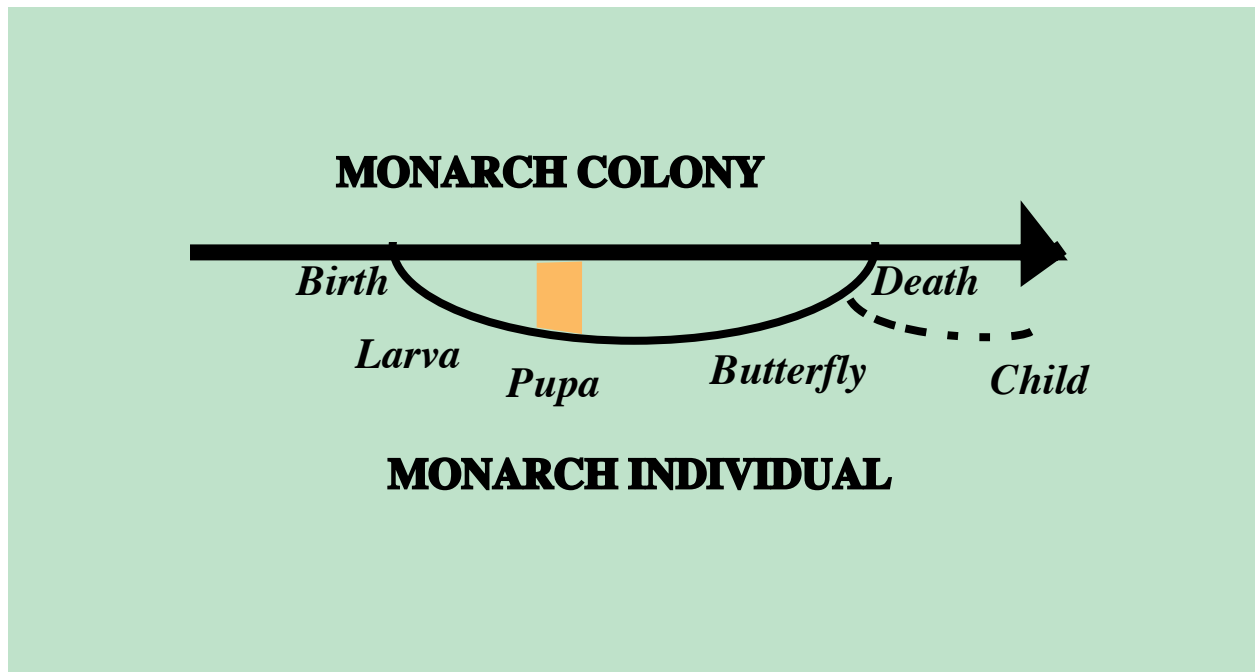


Figure 3. Bifurcation diagram showing attractors of the morphic field as a function of time. The hanging loop denotes life cycles of an individual butterfly of the colony.

Biography of a monarch:

1. Egg: five days
2. Birth
3. Larva (caterpillar), 5 instars of 2-7 days: ca 3 weeks.
4. Making the pupa (chrysalis): 1 day
5. Metamorphosis: ca 1 week
6. Butterfly: 2-6 weeks in summer
7. Reproduction: anytime after the first few days
8. Death: shortly after mating

Note the overlap of a few days while the parent fails, and the egg grows.