



In Context

Number 35 Spring 2016

The Newsletter of The Nature Institute

Letter to Our Readers 2

NOTES AND REVIEWS

A Day in the Life of a Chicory Flower / *Craig Holdrege* 3
Of Machines, Organisms, and Agency / *Stephen L. Talbott* 8

NEWS FROM THE INSTITUTE

2016 Winter Intensive for Farmers and Apprentices 10
Eighteen Monday Mornings of Goethean Science 12
Out and About 12
Still Ahead 12
Spring and Summer Events at the Institute 13
Thank You! 13
Summer Course 2016 24

FEATURE ARTICLE

Creativity, Origins, and Ancestors / *Craig Holdrege* 15

#35



The Nature Institute

Dear Friends,

It is hard to find an area of life today that does not provoke troubled introspection—we need only think of the strife in the Middle East, the refugee crisis in Europe, or the current political season in the United States. The question arises, “What am I doing to make a difference in a challenging and unhealthy environment?” The same question is posed for issues more closely related to the scientific research and educational work of The Nature Institute: genetically modified organisms (including humans), global warming, environmental pollution of various sorts, and the rapidly inflating, often grotesque dreams of synthetic biologists—these, too, force us to ask, “What are we doing to oppose destructive tendencies and promote the welfare of humanity and the planet as a whole? Where is our *activism*?”

One answer is that it doesn't exist. We are not protesting and marching, not sponsoring letter-writing campaigns, not pushing for this or that piece of legislation, not even (at least as a central focus) writing in direct support of activist campaigns. Are we, then, abdicating our responsibilities as citizens of this country and the global community?

Some might say so. But we would like to think there is another answer to the question about our activism. There is, after all, not much use in fighting against a disease if one doesn't know what sort of disease it is, what causes it, and what might tend toward its healing. A massively organized campaign to secure a piece of legislation might, by sheer reason of its funding and the effective mobilization of concerned citizens, achieve temporary success in blocking, for example, a particularly reckless project to engineer genetically modified organisms. And we, for our part, are intensely grateful that there are those willing to support such efforts with their pocketbooks and their time. Without their dedication, our society might be overwhelmed so quickly with unexpected difficulties that there would be no time to encourage new attitudes rooted in appreciation for the intrinsic value of all living beings.

But this raises the question where those healthier attitudes might come from. What long-term good can be achieved by a temporary legislative victory regarding genetically modified organisms if the society at large remains unable to see organisms as anything other than harvestable resources and objects for technological manipulation? The insults these organisms must endure will be endless—and holding back the tide of insults will ultimately be impossible—unless an understanding of the lives of organisms can be attained such that they themselves begin to inspire a respect for their ways of being and their needs.

There are, of course, many ways to attack this fundamental problem. But we would like to think that our work, as exemplified in this issue, illustrates at least two or three of those ways. This may not be activism in the most common sense, but we hope it serves an essential need of those “manning the barricades,” as well as of the larger public. After all, we need—all of us together—to come to an ever deeper understanding of what we are fighting for.

Craig Holdrege

Steve Talbott

STAFF

Linda Bolluyt
Colleen Cordes
Bruno Follador
Craig Holdrege
Henrike Holdrege
Veronica Madey
Stephen L. Talbott

ADJUNCT RESEARCHERS/FACULTY

Jon McAlice
Marisha Plotnik
Vladislav Rozentuller
Nathaniel Williams
Johannes Wirz

BOARD OF DIRECTORS

John Barnes
Siral Crane
Douglas Feick
Craig Holdrege
Henrike Holdrege
Marisha Plotnik
Jan Kees Saltet
Signe Schaefer
Jeffrey Sexton
Douglas Sloan
Nathaniel Williams

BOARD OF ADVISORS

Will Brinton
Ruth Hubbard
Gertrude Reif Hughes
Wes Jackson
Andrew Kimbrell
Fred Kirschenmann
Johannes Köhl
George Russell
Langdon Winner
Arthur Zajonc

In Context

Copyright 2016 The Nature Institute.

EDITOR: Stephen L. Talbott

LAYOUT: Mary Giddens

Copies of *In Context* are free while the supply lasts. All issues are posted on the Institute website. Our *NetFuture* newsletter is available at: <http://netfuture.org>.

The Nature Institute
20 May Hill Road
Ghent, New York 12075
Tel.: 518-672-0116
Fax: 518-672-4270
Email: info@natureinstitute.org
Web: <http://natureinstitute.org>

The Nature Institute, Inc.,
is a non-profit organization
recognized as tax-exempt by
the IRS under section 501(c)(3).

A Day in the Life of a Chicory Flower

CRAIG HOLDREGE

WHEN YOU WALK ALONG ROADSIDES in the early morning in summertime, you may be lucky enough to encounter the radiant blue flowers of chicory (*Cichorium intybus*). It's almost as if the deep blue sky that you only see in the clear air on a high mountain has been spirited into the plant and shines at you in its many flowers.

Chicory is of European origin and followed European travelers and settlers to virtually all parts of the world. It inhabits the disturbed soils of roadsides, and in the summertime its blue flowers provide a kind of counterpoint to the many white- and yellow-flowering plants that also inhabit such transitional areas. What draws your attention are the blue flowers. Amidst the green vegetation of all the other species, you hardly see the whole chicory plant with its long, narrow and almost leafless branches. These branches carry the flowers, which are dispersed on the plant in no apparent pattern. On any given day a plant might have five to twenty flowers. If you are very lucky, you may see a rare plant with white flowers.

But “flower” is not the correct term. What you are looking at when you recognize a chicory “flower” is, botanically speaking, an inflorescence, that is, a group of flowers (what I’ll call a flower head). This means that the twenty or so “petals” of the apparent flower are actually parts of individual small flowers that are called florets. Each floret is a complete flower that consists of five fused petals (note the five “teeth” at the outer margin), a stamen tube and a pistil (see diagram). So a chicory flower head is a kind of “super flower”— an enhancement of flowering in which individual flowers become the parts of a larger integrated whole.



Flowering chicory plant in its surroundings next to a roadside in July.

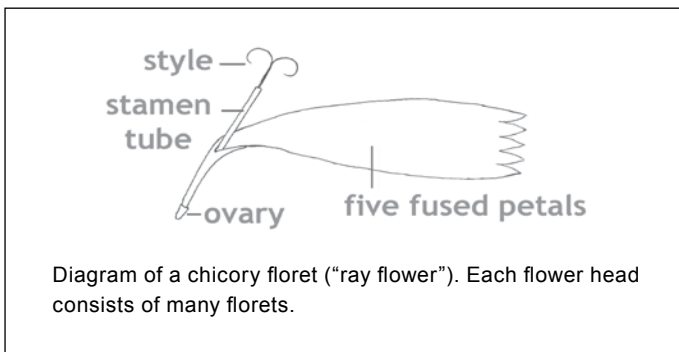


Diagram of a chicory floret (“ray flower”). Each flower head consists of many florets.



Top part of a chicory plant with flower head buds, one open flower head and wilted heads.

All members of the Aster family, to which chicory belongs, have such “super flowers”; a close relative is the common dandelion.

One special feature of the chicory is that typically each individual flower head opens only for part of one day, while the

whole plant opens new flower heads each day for many weeks from midsummer into early fall. It is not a plant with one burst of flowering. Rather, it produces many little daily bursts of blue over a long period of time. It brings about a fascinating synthesis of short-lived individual flowers and longevity in the flowering process of the whole plant.

In mid-July I decided to follow one flower head near The Nature Institute over the course of a single day. You have to go out before sunrise (which occurs at around 5:30 am) to see the bud begin to open in which the flower head lies hidden. In the dim dawn light I could already see the tip of the flower head in the opening bud. It is a deep and intense blue-violet color. The outside of the florets is covered with fine hairs that sparkle with dew drops. As it became bright enough right around the time the sun rose, I began taking photos (I didn't want to use a flash).

Over the course of the next few hours the flower head opens. First the florets extend upward and each one begins to unfurl at the tip and along its margins. As the florets are unfolding, the flower head as a whole opens out toward the horizontal plane. The deep violet blue color lightens in this process and becomes a radiant lavender blue. The transformation of color in the florets in a way mirrors what happens in the sky. As the clear dawn sky is dark and almost violet and lightens through shades of dark blue to the lighter "sky blue" of full daylight, so does the color of the chicory flower first brighten and then lighten during the course of the morning.

The outermost florets open first and are then joined by the remaining florets to form a slightly concave surface consisting of the fused petals of the florets. The radiating quality of the resulting flower head is enhanced by the presence of the five teeth at the tip of each floret. As the petals unfold, the stamen tubes become visible in the center of the flower head. Each floret has one stamen tube. As a group, the stamen tubes radiate up and outward from the center of the flower head. The stamen tubes are at first light blue and quickly become dark blue and keep that color as they later fade.

However, they remain white at their base, and the petals are also lighter at the base, so that the center of the flower head is brighter than the rest and provides a beautiful contrast to the surrounding blue tones.



5:27 am



5:43 am



6:58 am



6:59 am



7:35 am



7:33 am



8:07 am



8:07 am



8:41 am



8:41 am



9:35 am



9:35 am

The flowering process continues with a further development that shows itself on and around the stamen tubes. Out of the tip of each stamen, fine, paired filaments grow. These are the two branches of the style. They carry with them a whitish powder. This is the flower's pollen. It is not yellow or orange as in most flowers, but white. The pollen is generated

inside the stamen tube and as the style grows up through it, it collects pollen and brings it out into the light of day.

It is now 8:30 in the morning. Some of the pollen gathers at the tip of the stamens and some of it remains on the style branches. The styles themselves are blue, but one hardly sees this when they emerge covered with the white pollen. The



The insects arrive. 10:30 am



12:38 pm



1:32 pm



1:32 pm



2:26 pm

pollen gathered at the stamen tube tips and the style ends mirrors, color-wise, the white at the base of the stamens.

Very soon after the pollen appears, the first insects arrive at the flower head—little flies, wasps, and native bees. This is something remarkable when you think about it: these insects, which are dispersed who knows where in the larger environment, gather at the chicory just when the pollen makes its appearance. Are they drawn through smell, vision, or in some other way? Having landed on the flower head, they crawl around on the stamen tubes and gather and eat the white pollen.

The insects also pollinate the flowers. Much later in the season, small hard fruits will develop at the base of the florets, and in contrast to the fruits of dandelions, which sail off into the wind, chicory fruits either fall to the ground in fall and winter or are carried off by birds.

The styles continue to grow out of the pollen tubes, and around 10:30 am the flower head has reached its maximal unfolding. It does not stay in this state for long. By 12:30 pm the flower head is decidedly paler and in the process of closing. The insects are gone. On this day the sun reached the highest point in its arc through the sky—true midday—at about 1pm. So already before midday the chicory flower head begins to wilt and close. Chicory has flowers of the early morning that fade as daylight reaches its greatest intensity. (On overcast days, the flowers can remain open into the afternoon.)

Within a few hours the petals lose most of their color, begin to wilt, and the flower head closes by midafternoon. A pale violet, slightly browning remnant of the flower head remains attached to the stem overnight. In the case of the flower head I was observing, it remained all day the next day as well and then fell off.

Day in and day out something similar happens with every chicory flower head. Each plant shows us its past in the wilted flower heads, its future potential in the yet unopened buds, and its present in the radiant and fleeting life of its blue flower heads.



3:31 pm



6:02 pm



4:54 pm the next day.

Our Challenge Grant: You Can Help Sustain the Work!

Two Nature Institute supporters have generously offered to donate up to \$5,000 as a matching gift to support our work—work from which we share highlights in each issue of *In Context*. At The Nature Institute we strive to let the deeper qualities of nature reveal themselves; to explicate a way of scientific knowing that can engage with life authentically and responsibly; to practice experiential learning in our adult education programs, with nature as our master teacher; and in all we do, to cultivate capacities that are illuminating and health-bringing at this time of both great need and great potential.

Thanks to this challenge grant, every dollar you donate to The Nature Institute by June 30 will be matched, up to \$5,000. You can make a gift by check or credit card using the enclosed envelope, or by credit card through our website (<http://natureinstitute.org/friend/>).

Thank You!

Of Machines, Organisms, and Agency

STEPHEN L. TALBOTT

This is a section from the middle of a longer article, “Can Darwinian Evolutionary Theory Be Taken Seriously?” whose publication date is uncertain as of this writing. For a link to that article, when it does appear, go to <http://BiologyWorthyofLife.org>.

When we build a machine, we manipulate materials of the world so as to configure a set of causal physical relations adequate to our purposes. Following this configuration, the machine’s performance is shaped by those causal relations, so long as outside factors do not interfere. Everything “rolls along” within the pre-established physical constraints. Engineers and philosophers speak of the “initial conditions” — the original, designed arrangement — of the system, which then operates in a predictable fashion based on that arrangement.

Organisms are not machines.¹ They are not endowed with a set of initial conditions, after which they simply carry forward the mechanistic implications of those conditions. It is grotesque even to try to imagine a single-celled zygote determining in any machine-like manner all the subsequent growth and development leading to heart, lung, and intestine, or to oak, salmon, or tiger.

The organism is, moment by moment, establishing *new* “initial” conditions. It is as if a machine were being redesigned at every moment — or would be like that if the organism were machine-like. In actuality, the organism’s *life* is a continual “self-redesigning” — or, better, a self-expressing, or self-transforming. Its parts are not assembled once for all; they are *grown* on the spot during development, so that the functional unity of the organism — the way its parts play together, and even what the parts are — obviously must be changing all along the way. If the organism *were* machine-like, it would be a different, newly constituted and redesigned machine each time you looked at it.

So the organism possesses, or is, a power of *origination*. It constantly brings about something new — something never wholly implied or determined by the physical relations of a moment ago.² We could also think of it as a power of self-realization. The “design work” accounting for the organism is an activity inseparable from the organism’s own life. It is an expression of that life rather than a cause of it.

Machines and organisms, therefore, have this in common: whatever is *responsible* for orchestrating causal arrangements — initially, in the case of machines, or continually, in the case of organisms — cannot itself be *explained* by those arrangements. This single fact calls into question the entire

habit within biology of trying to explain the present purely as the consequence of material forces playing out of the past.

It’s true that biologists speak incessantly of mechanisms and of machine-like or programmed activity in organisms. But this is empty rhetoric. No one has ever pointed to a computer-like program in DNA, or in a cell, or in any larger structure. Nor has anyone shown us any physical machinery for executing such program instructions. Nor, for that matter, has anyone ever explained what constrains diffusible molecules in a watery medium to carry out elaborate operations, such as DNA replication or RNA splicing.

The complexity of these operations, the ever-shifting patterns of cooperation required from the molecules, the sequencing of steps in a prolonged narrative, and the attention to an ever-shifting context that says, “Head in this direction” under one set of conditions and “Head in that direction” under a slightly different set of conditions — none of this is governed by machine-like controls that coerce the molecules into their essential, infinitely varying, and context-sensitive roles in the larger narrative. Yet, despite the lack of controlling mechanisms, the achievement is vastly more sophisticated than any intricately choreographed, well-rehearsed performance by a ballet troupe.

Limits of our understanding

How, then, do the organism’s self-designing, or self-expressing, intentions compare with our own purposive, engineering activity in designing machines?

There is a crucial difference between the two. We do not cause the parts of a machine to *grow* together; we *put* them together. Our own, one-time designing activity impinges on the machine “from the outside.” This is best understood by comparison with organisms.

As we have seen, the life of the organism is itself the designing power. Its agency is immanent in its own being, and is somehow expressed at the very roots of material causation, bringing forth this or that kind of growth with no need for the artifice of an alien hand arbitrarily arranging parts and causal relations this way or that. The choreographing is brought about, it would appear, from that same depth of reality where the causal forces themselves arise, not from “outside.” However we conceive this “inner” place, it is, at least for now, inaccessible to our own engineering prowess.

The limitations of our understanding of the causal and intentional processes in organisms should not surprise us. A great deal is currently hidden from us. We know very

little about what forms of consciousness and intention occur in the world. We find ourselves already baffled when comparing our own consciousness to that of an infant, a chimpanzee, a dog, or a crow. And we are no less frustrated when we try to trace the apparent continuity of our consciousness with subconscious impulses, instincts, reflexes, various “psycho-somatic” processes, and (the ultimate challenge) the consciously willed physical activity of our bodies, in which all those cellular processes so often considered “unintelligent” are clearly caught up as able co-participants along with our conscious intentions.³

Acknowledging our ignorance is as important as trying to nail down what we know, for it can help to spare us that perennial failure of understanding: the inability, or unwillingness, to recognize the boundaries of our understanding, followed by the refusal to imagine the range of previously unanticipated possibilities that might allow us to transcend those boundaries.

The upshot of all this? Clearly, the intelligence and intention at work in organisms — and in our own bodies — far outstrip any creative powers we can exercise in building things. We humans cannot yet approach with our conscious thinking and willing the self-expressive powers evident throughout the biological realm. Given the limitations of our understanding, it may be a dangerous thing merely to manipulate organisms we cannot yet comprehend.

How to speak of intelligence and purpose

So what about the use of problematic terms such as “intelligence,” “purpose,” “intention,” and “agency”? Our own purposive activity in designing machines commonly involves a *conscious* play of volition (intention) and thought (intelligence). It is, relative to the creative powers at work in physiology, a rather *lamed* consciousness with limited powers of activity. But it is also a rather *free* consciousness, inasmuch as we can exercise it more or less at will upon true or false, healthy or unhealthy contents.

When, however, I refer [elsewhere in the larger article] to the organism’s intelligent agency, or its purposiveness, or its directed, goal-driven functioning, I do not imply anything equivalent to our own conscious purposing. But neither do I suggest something *inferior* to our particular sort of wisdom and power of action. If anything, we must consider organic life to be an expression of a *higher* sort of intelligence and intention than we ourselves can yet imagine achieving in the technological realm.

Rather than over-defining terms and transgressing the boundaries of my own understanding, I am inclined to leave the matter there. I will tend to use terms in the way we commonly use them, with the understanding that the reader will keep in mind the above considerations.

Given the scientific culture’s radical denial of the psychic and voluntary, I judge it better to err on the side of anthropomorphism than to encourage the usual dismissiveness of all interior reality.

In sum:

Both machine and organism: the intelligent agency responsible for configuring causal relations cannot be explained by those relations.

Machine: the designing activity occurs up front.

Organism: the self-expression (“self-design”) is life-long.

Machine: the designer’s intentions are brought to bear upon the machine’s parts “from outside.”

Organism: its intentional work is immanent within the organism itself; it is the organism’s own activity.

Machine: the artifact comes to exist as a result of designing activity.

Organism: the physical organism never *comes to exist*; its growth is always the transformation of an already existing and living whole.

Machine: its functioning can be described in terms of the lawful playing out of its designed structure. This reflects the intentions of the designer.

Organism: its functioning is a narrative of the organism’s own meaning, always with a creative element (bringing about something new).

One other note. Our recognition of intelligent and intentional productions does not require us to understand everything about their source. We have no difficulty distinguishing the significance of letters on a page from that of pebbles distributed on a sandy shore, even if we know nothing about the origin of the text. We can declare a functioning machine to be a designed object, whether or not we have any clue about who designed it. And if we find live, intelligent performances by organisms, we don’t have to know how, or from where, the intelligence gets its foothold before we accept the testimony of our eyes and understanding.

REFERENCES

1. Talbott, Stephen L. (2014). “Biology’s Shameful Refusal to Disown the Machine-Organism.” Available at http://natureinstitute.org/txt/st/org/comm/ar/2014/machines_18.htm.
2. Holdrege, Craig (2016). “Creativity, Origins, and Ancestors: What Frog Evolution Can Teach Us,” *In Context* #35. Available at <http://natureinstitute.org/pub/ic/ic35/frog.pdf>.
3. Talbott, Stephen L. (2015). “From Bodily Wisdom to the Knowing Self” Available at http://natureinstitute.org/txt/st/org/comm/ar/2015/bodily-wisdom3_28.htm.

Plants and the Living Earth Holistic Science in Service of Agriculture

From February 7 to 12, twenty farmers and apprentices came to the Nature Institute from local farms, northeastern states, and also from Minnesota, Wisconsin, California, and Canada. With Craig, Henrike, and Bruno they explored:

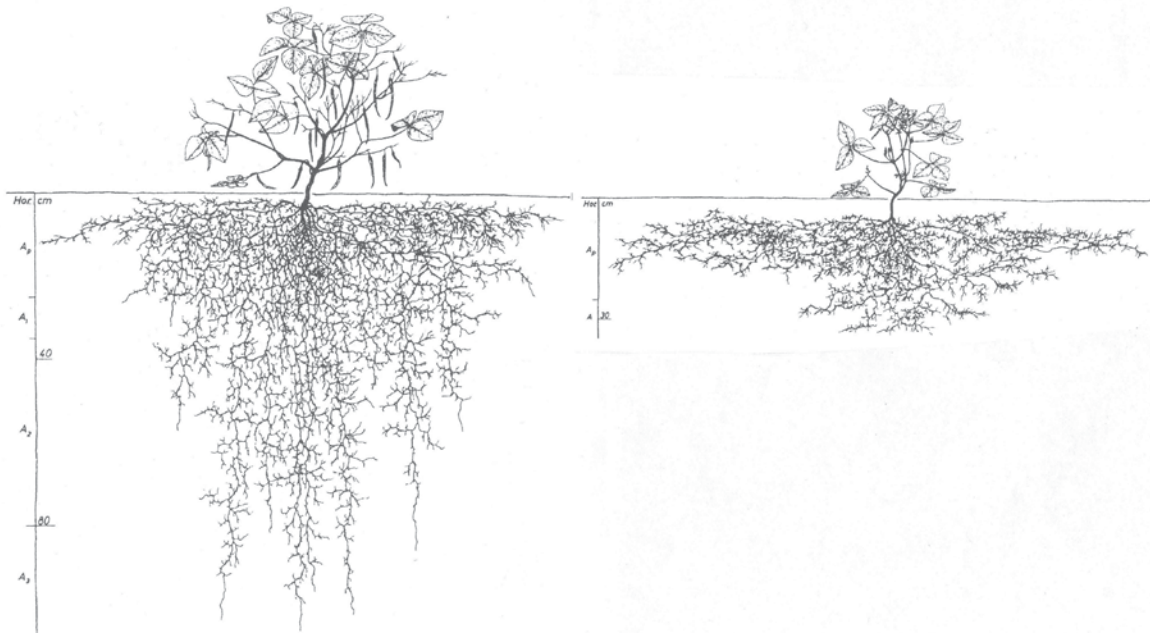
Plants: Metamorphosis; plant growth and development in relation to the environment with a focus on soil; domestication characteristics of food plants; assessing quality through our senses.

Earth, water, air and warmth: Practical exercises and observations to understand these essential qualities that inform all life on earth.

Soil, compost, and phenomenological chemistry: The dynamic process of compost formation; qualitative assessment; the qualities of the chemical elements carbon and nitrogen.

Some Comments from Course Participants

“It was wonderful. I’m certainly overwhelmed by all that we covered, but not in a bad way (for once). In other words, the flow of the days worked really well for me – from the variety of topics and the way many were revisited, to the frequency of breaks and the different leaders and presentation styles. For an experiential learner, the demonstrations, pictures, stories, and activities were invaluable. It’s been awesome also to spend a whole week with this group and this content, giving time for individual processing and for synthesizing with others. I feel I’ve made many small and several great steps in my education.” (Apprentice)



Bush bean plants growing in different soil conditions. In both cases humus-rich loam in the upper thirty centimeters; on the left, loam continues, but less humus-rich; on the right, the soil becomes sandy and gravelly where no more roots are growing. (After Kutschera)



Flower morphology



A steaming pile of manure at Hawthorne Valley Farm



Experiencing the quality of warmth in different objects

“This past week has been incredibly stimulating and inspiring. The combination of the different areas and themes, moving through the different life processes – and they within me – have given me a new perspective and appreciation. I enjoyed the variety of activities and relationship between theoretical, philosophical, spiritual, scientific, and real-life connections. I feel like the week was broken up well, with enough time dedicated to fully explore each element we were learning with. Having the day broken up in different blocks also helped give me a holistic understanding ... of what we were observing.” (Farmer)



Fluidity, laminar flow, and turbulence: creating a vortex

“I thought the course was thought-provoking, engaging, intimate, and fun. I thought that it was structured brilliantly. An overarching theme of plants and the soil and weaving in the [chemical] elements and this aspect of quality allowed for new insights, perspectives, and questions to bubble up. There was plenty of room for discussion and engagement with the students. The weaving of the science experiments, chalkboard lessons, and outdoor activities, and well-timed snack breaks kept me engaged and interested. This was quite a unique educational experience and I would love to come back for more.” (Farmer and Social Therapist)



The characteristics of different vegetables

Eighteen Monday Mornings of Goethean Science

As part of Free Columbia's six-month course in painting, nature study, and social change, we offered eighteen Monday mornings (9 am to 12:30 pm) at The Nature Institute. Five full-time Free Columbia students participated, and as many as fifteen other individuals took part in the various modules. Craig taught five sessions on plants and animals, Henrike eight sessions on the visual world, optics, and color, and Bruno four sessions on landscape and agriculture. In the concluding review session, the students commented on how, as a result of the course work, they had become much more attentive to their perceptions and also to the contextual nature of all phenomena. We were gratified to hear how strongly the course had affected the students. It reconfirmed our commitment to the experience-based and reflective kind of learning process we strive to offer in our education programs.

Out and About

As part of our Living Soils initiative, **Bruno Follador** gave a variety of talks, workshops, and on-farm consultations around the country and abroad during this past winter and spring. Here is a glimpse of his activities:

- In early February Bruno gave two workshops at the "**Farming for the Future**" **Agricultural Conference** organized by the Pennsylvania Association for Sustainable Agriculture (PASA). He spoke on "Biodynamic Agriculture: A Qualitative Approach to Farming" and on "The Art and Science of Composting: A Biodynamic Approach." The conference took place in The Penn Stater Conference Center, State College, Pennsylvania.
- In mid-February Bruno gave two talks at the annual conference of **The Fellowship of Preparations Makers**, a group within the Biodynamic Association interested in deepening their understanding of the biodynamic soil and compost preparations. His first talk was on "What are Qualities?" and the second one was on "Portraying Soils and Compost: Color, Form and Pattern." This year's conference was at Yokayo Roots Ranch, Ukiah, California.
- Bruno was invited to give an early-March series of talks and workshops in the United Kingdom. His first workshop took place at **Emerson College**, where he spoke on "The Art and Science of Biodynamic Composting: Practices and Insights." After this workshop one of the participants asked Bruno to consult at his biodynamic farm—**Albury Vineyard**—located in the Surrey Hills in Albury. The second workshop was held at **Ruskin Mill** on the theme, "Ehrenfried Pfeiffer's Chromatography: Portraying Soils

and Compost through Color, Form and Pattern." At Coventry University's **Centre for Agroecology, Water and Resilience**, he gave a talk on "Practices and Insights of Biodynamic Agriculture: Developing Dynamic Ways of Seeing and Working with Compost and Ehrenfried Pfeiffer's Chromatography." Finally, at **The Field Center** (Ruskin Mill), Bruno gave an evening talk on "Encountering the Amazon: There is More to Seeing than Meets the Eye."

- In early April Bruno consulted at the **Fellowship Community** in Spring Valley, New York, regarding their composting practices. He also delivered a public talk in the evening on "Soil, Compost and Community."
- Finally, at the end of April Bruno gave a presentation at the **Farm School in Massachusetts** on "Developing dynamic ways of seeing and working with Compost."
- **Henrike** was invited to spend a week in April at the **Eugene, Oregon, Waldorf School** to work with its faculty and students in an education program on teaching mathematics. In addition to a Saturday workshop, she had four sessions each during the week with lower school and middle school teachers. She also gave a public talk on "Math and Science in the Middle School: Opening or Closing Doors?"

Still Ahead

- In mid-May Bruno will be consulting for **Biodynamic Services** in Chateau, France. He will also be offering a public workshop on Biodynamic Composting Practices.
- At the end of May Bruno will give a weekend workshop at **Avena Botanicals** in Maine on "Practice and Insights of Biodynamic Composting: Developing Dynamic Ways of Seeing and Working with Compost."
- Craig is one of a dozen educators and scientists invited by Wes Jackson of **The Land Institute** (Salina, Kansas) to serve as the inaugural core faculty for a major new initiative to develop Ecospheric Studies. The first meeting will be in June.
- **New Two-Year Program in Brazil: "Seeing Nature Whole."** Henrike and Craig will be teaching a two-week course in Brazil on the Goethean approach to science. With twenty-five participants already committed as of last March, the course is full and has a waiting list. This is the first two weeks of a four-week program during July 2016 and 2017 at the Associação Sagres, a center for adult education in Florianópolis in southern Brazil (<http://www.asssagres.org.br/>). Henrike and Craig will teach in English, and all classes will be translated into Portuguese. The course is for people who seriously wish to apply the Goethean scientific methodology in their own work and carry it further.

Spring and Summer Events at the Institute

Benefit Screening: “Even Though the Whole World Is Burning” (March 15)

About 60 people viewed this screening of a beautiful and insightful documentary about the Poet Laureate W.S. Merwin, directed by Stefan Schaefer. The son of Nature Institute board member Signe Schaefer, Stefan graciously allowed us to show the film as a benefit for the Institute.

Mathematics Alive! Supporting Students at the Threshold of Adolescence (March 18 – 20)

A geometry workshop for middle school teachers with Henrike Holdrege and Marisha Plotnik

Phenomenological Research within the Human Encounter (April 1, 8, and 15)

Three talks by John Cunningham, Waldorf educator and trainer in nonviolent communication

- “Introspective Observations on the Inner Dialogue: Practical Illuminations of Marshall Rosenberg’s *Nonviolent Communication*”
- “Becoming Through the Other: Social Inquiry through Goethe’s *Way of Seeing*”
- “Conflict, Community, and Slow Dialogue: Shared Care through Dominic Barter’s *Restorative Circles*”

Working with the Principle of Polarity in Projective Geometry (April and May)

A course in eight sessions with Henrike Holdrege

Soil, Culture, and Human Responsibility (April 22)

A talk by Bruno Follador in celebration of Earth Day

Doing Phenomenology in Teaching Science: Performance Art that Evokes Insight (May 23)

A talk by physicist Wilfried Sommer

Wilfried teaches physics in Waldorf schools, and is Assistant Professor at the School of Education at Alanus University in Germany.

SUMMER COURSE 2016 — *See announcement on back cover*

Thank You!

We are deeply indebted to those friends of The Nature Institute who have helped to sustain our work by contributing money, goods, or services between October 1, 2015 and March 31, 2016.

PLEDGES

Nancy Kay Anderson
Janet Barker
Betty Brenneman
Charlie Doheny & Cate Decker
Nir Eliav
Michael & Patricia Holdrege
Susan Starr
Trish Streeten
M. Kelly Sutton
Jo Valens & Michael Thomas
Sherry Wildfeuer

DONORS & VOLUNTEERS

Finan Adamson
Warren & Mary Adis
Leonore Alaniz
John & Monica Alexandra
Peter Alexanian

Carol Alpert
Johan Alvbring
David Anderson
Elizabeth & Arthur Auer
David Auerbach
Brigida Baldszun
John & Diane Barnes
Olga & Felix Bauer-de Wit
Sylvia Bausman
Ursula & Klaus-Georg
Becher
Gerhard Bedding
Christina Beneman
Chris Bennett
in honor of Craig &
Henrike Holdrege
Jeanne Bergen
Linda Bergh
in memory of Kirsten

Mike Biltonen
Olivia Bissell
in honor of Jeanne Bergen
Glenda Bissex
in memory of John Wires
Rose Bohmann
Benjamin Bokich
Jody Bolluyt & Jean-Paul
Courtens
Linda & David Bolluyt
Bari Borsky
Timothy Brady
Arlene Braithwaite
John Breasted
Paul Breslaw
Eileen Bristol
Caleb Buckley
Frank Buddingh &
Nina Arron

Lynn & Donald Bufano
Dorothy Carney
Maureen Carolin
Mary Ann Carreras
Betsy Cashen
Jim & Meg Cashen
Lynn Charlton
Ivan D. Chase
Stephen Coleby
Wendy Bobseine Conway
Colleen Cordes & Robert
Engelman
Barbara Coughlin & John Fallon
in honor of Douglas Sloan
Siral & David Crane
Harriett Crosby
John Cummings
John Cunningham &
Cat Gilliam

Jim Davis & Brooke Heagerty
 Matthew Davis & Sophia Sherman
 Pamela & Terry DeGeyter
 Susan Delattre
 Peter & Dorothy Denning
 Elizabeth Dews
 Dennis & Marianne Dietzel
 Frank & Cheryl Doble
 Sandra Doren
 Alexander & Olivia Dreier
 Sandragail Dunn
 Mark Ebersole
 Hanna Edelglass
 in memory of Stephen Edelglass
 Bob & Cecelia Elinson
 Stella & Peter Elliston
 Karen & James Emerson
 Lee Ann Ernandes
 Douglas Feick
 Spencer Fenniman & Jill Jakimetz
 Juliana Field
 Virginia Flynn
 in memory of David Mitchell
 Nancy & William Foster
 Nick & Gisela Franceschelli
 Eileen Frechette & Ed Gutfreund
 Branko Furst & Christina Porkert
 Joyce & David Gallardo
 Jon Ray & Meg Gardner
 Mark & Adrienne Gardner
 Truus Geraets
 Judith Pownall Gerstein
 Mary Giddens
 Betsy Gimenez
 Gary Gomer
 Michael Gore
 John Gouldthorpe
 Glynn & Anthony Graham
 Martha Grib
 Alice & Trauger Groh
 Joan Dye Gussow
 Warren Haddon & Corrie Triewth
 Daniel & Karin Haldeman
 Paula Hall
 Amy Hart
 Gunther & Vivian Hauk
 Graham Hawks
 Ingrid Hayes
 Nita Hazle
 Jennifer Helmick
 Marsha & Ed Hill
 JoAnn & Mark Holbrook
 Barbara Holdrege & Eric Dahl
 Christina Holdrege & Edmund Muller
 Craig & Henrike Holdrege
 Mark Holdrege
 Tom Holdrege & Peggy Reis
 David & Brenda Hollweger
 Jamie Hutchinson
 George Ivanoff
 Wes & Joan Jackson
 Ina Jaehning
 Linda Jolly
 Kevin Jones
 Susan Joplin
 Seth Jordan
 Annette & Christoph Kaiser
 Gloria Kemp
 Ann Kleinschmidt
 Haijo Knijppenga
 Myron Koch
 Nancy & Robert Kossowsky
 Arn Krugman
 Johannes Kühl
 Calvin & Chisora Kuniyuki
 Elan Leibner & Tertia Gale
 Yotam Lev & Gili Melamed-Lev
 Martin & Judith Levin
 Art Levit
 Christof Lindenau
 Penelope Lord
 Merrily Lovell
 Peter Luborsky
 Miriam MacGillis
 Ben & Veronica Madey
 Julius & Gertrude Madey
 Hans Malmberg
 Carmeletta Malora
 Rafael Manacas
 Are & Karin Mann
 Vincent D. Mann
 Irene Mantel & Tim Hoffman
 Chris Marlow
 Michael Mason
 Lawrence & Robin Mathews
 Kathy Matlin
 in memory of Ron Richardson
 Kathleen Mayer
 Patrice & David Maynard
 Rebecca McGrath
 Robert McKay
 Bill Meacham
 Mac & Ellen Mead
 Rick Medrick
 Philip Mees & Linda Connell
 Christoph & Annelien Meier
 Mary Elizabeth Merritt & Raymond Crowler
 Fred & Masako Metreaud
 Bruce Middendorf
 David Miller
 Daphna H. Mitchell
 Rick Mitchell
 Karl-Peter & Mechthild Möller
 Pam & Rob Moore
 Joyce Muraoka
 Marcia Murray
 Astrid Murre
 Robert & Marion Ober
 Robert Oelhaf
 Frederick Otto
 Traute Page & Eric Meyer
 Tim & Maggie Paholak
 Renate Pank
 Joseph & Emilie Papas
 Linda Park & Cotter Luppi
 Susan Peterson
 Grace Ann Peysson
 Marisha Plotnik & Ihor Radysh
 Mary Lee Plumb-Mentjes & Conrad Mentjes
 Marsha Post
 in memory of Joan Allen
 Numael & Shirley Pulido
 Gina Qualliotine & Richard Green
 Judy Ratkowski
 in memory of Douglas Delray Post
 Anna & Brian Reé
 Wolfgang & Josefine Reigl
 Renate Reiss
 Mark Riegner
 Roger & Dory Rindge
 Geoffrey Robb
 Christina Root & Donald Jamison
 Ursula Röpke & Marcel Ferrando
 Margaret Rosenthaler
 Roland Rothenbacher
 George & Leonore Russell
 Lucille Salitan
 Elisa Saltet
 Jan Kees & Polly Saltet
 Ari-Paul Saunders
 George Savastio & Beth Devlin
 Liza Trent Savory
 Signe & Christopher Schaefer
 Ann Scharff
 Lucy Schneider
 in honor of and with gratitude for Marisha Plotnik
 Steffen & Rachel Schneider
 Karl Schurman & Celine Gendron-Schurman
 Volker Seelbach & Drucilla Boone-Seelbach
 Jeff Sexton & Connie Cameron
 Roland Sherman
 in memory of Rosemarie Sherman
 Greg Shultz
 Meinhard Simon
 Jeanne Simon-MacDonald
 Peter & Phyllis Skaller
 Amie Slate & Loren Smith
 David & Christine Sloan
 Douglas & Fern Sloan
 Patricia Smith
 Jerome & Rebecca Soloway
 Mado Speigler
 Joanne & Charles Spitaliere
 John & Elsie Sprague
 Claus Sproll
 Ann Stahl
 Carolyn Stern
 Mariola Strahlberg
 Elizabeth Sustick
 Candyce Sweda
 Christian Sweningsen
 Florian Theilmann
 Mary Thieme
 Thorwald Thiersch
 Heather Thoma & Paul Salanki
 Roberto & Donna Marie Trostli
 Carsten Ullrich
 Els & Jaap van der Wal
 in honor of publications in *In Context*
 Conrad & Claudia Vispo
 Andree Ward
 Chip Weems
 Christian Wessling
 Gisela Wielki
 Basil & Christiana Williams
 Hugh Williams & Hanna Bail
 Nathaniel & Andrea Williams
 Christian Wittern
 Lyt Wood
 Waltraude Woods
 Joel Zenie
 Cathy Zises

 ORGANIZATIONS

 Anthroposophical Society in America
 Berkshire Taconic Community Foundation
 Edwards Mother Earth Foundation
 Kalliopeia Foundation
 The Kathy Yoselson Fierce Determination Fund of The Community Foundation
 Mahle Foundation
 The Michael Foundation
 Rudolf Steiner Charitable Trust
 Trust Advised Fund of RSF Social Finance
 Rudolf Steiner Library
 Salvia Foundation
 Software AG Foundation
 T. Backer Fund, Inc.

Creativity, Origins, and Ancestors

What Frog Evolution Can Teach Us

CRAIG HOLDREGE

I began a previous article by asking, “Does a frog come from a tadpole?” (Holdrege 2015). The straightforward and seemingly obvious answer is “yes.” Without a tadpole the adult frog could never develop. And of course the tadpole could never develop without adult frogs. In answering the question this way, we are looking at the feature of continuity in space and time, of continuity in the sense world. We can always point to something that is present, formed, and alive “out of which” a next phase of life can develop. And this something is clearly important, because without it nothing could develop further, and also because there is specificity connected with it: out of a salamander embryo a salamander develops and out of a frog embryo a frog develops. What exists in this way in the present is embedded in a long history. There have been thousands upon thousands of generations of wood frogs and bullfrogs. Over time the life history of a given species is repeated—with variations of course—again and again. There is in this sense remarkable stability, with species staying more or less the same for generations.

This is all true. But it also is incomplete and one-sided. It does not encompass a central feature of development and organismic life that only comes into view when we look at the same phenomena differently. For this we need to shift away from focusing on how what already “is” provides the basis for what becomes. Our emphasis is no longer the causal approach that reigns in the biological sciences with

its focus on how the past determines the present. Of course, what is antecedent makes possible and also constrains future development. However, it does not provide insight into the special characteristics that arise during development that make an adult frog so different from the tadpole. Since the genomes of the tadpole and the adult frog are virtually identical, it cannot be the genome that creates the differences between them.

The shift in perspective begins when we follow development and organismic life as process and transformation. When we stay in the flow of process itself, and notice the quality of changes that occur, something new shows itself. Instead of focusing on the past as determinant, we see ongoing creation. It is in this sense that we can accurately say that the frog *does not* come from or develop out of the tadpole. You cannot study the tadpole alone and gain the knowledge that it will develop into a frog. In each generation “adult frog” comes into being through breaking down “tadpole.” When developed, the adult frog actively maintains itself. From this perspective the organism shows itself as creative activity, agency, or being-at-work. The terms we use are not so important; what is important is that we perceive and become vividly aware of the creative, doing-nature of the organism.

When we bring these two perspectives together, we see that life plays itself out in the polarity between what has been created and creative activity. (We could also

Figure 1a. Tadpoles of the wood frog (*Rana sylvestris*). (Photo C. Holdrege.)



Figure 1b. Adult wood frog (*Rana sylvestris*). (Photo C. Holdrege.)



say: between what has become and what is becoming, or between what has been produced and what is producing.) And, as in any true polarity, you don't find one pole without the other; they are not opposites that can exist separately. In a living organism we observe what has been created (already formed substances, structures) and we find creative agency. And just as all forms and structures emerge out of the creative activity of the organism, so does the creative agency remain at work in and through what has already become. We are always dealing with formed life and the formative activity of life.

This double aspect of life is important. The formed life brings a kind of stability and constancy. We would not have anatomy textbooks, nor could we identify and classify groups, if there were not some form of constancy and stability. At whatever level you consider the organism—its DNA, its bones, or the countless generations of wood frogs that are always identifiable as wood frogs—there is stability. But it is essential to realize that such stability is not a static “is.” Every form, structure, or substance is always being actively brought forth and actively maintained. This is being-at-work. All products have been produced; every creature has been created. The active, creative agency of life is always present, not as a thing, but as the process of transformation—of coming to appearance and vanishing.

Every enduring organic structure, every way of being, is a dynamic and persistent pattern in time—a pattern actively and creatively brought forth at every moment. This is the case whether we are speaking of the form of the eye in a single frog or the overall characteristics of a given species.

We are dealing with similar issues when we consider evolutionary development. On the one hand we have the stable existence of life forms over long periods of time, and on the other hand we have the appearance of radically different life forms that never existed previously. The question is: how do we think about the relationship between what existed in the past and what arises as new types of organic forms during the course of evolution? A standard way of stating the relation would be: all life ultimately evolved from bacteria-like organisms that lived billions of years ago; or, modern humans evolved from ape- or chimp-like ancestors.

But what do these statements mean? The study of development in the present—as in the example of the metamorphosis of tadpole into frog—can sensitize us to the difficulties that are buried in such statements. It appears to me that just as we can say that a frog cannot be derived from a tadpole, we can also say that humans cannot be derived from earlier primates, or mammals and birds from reptiles, or

reptiles from amphibians, or amphibians from fish. In other words, inasmuch as a search for “ancestors” of a given group is looking to find more than temporal antecedents, is looking to find an explanatory “source” or “origin” of a group in the fossil record, it is misguided. It is a search full of expectations that cannot be fulfilled.

My aim in this article is to unpack a more living perspective and to consider the insights and questions it leads to.

Frog Fossil History

In fossils the earth preserves traces in the present of life past. For over 200 years geologists and paleontologists have discovered these fossil traces and striven to decipher and make sense of them. Inasmuch as we can read the fossil record, we gain an opening into the past. The fossil record presents us with a picture of a great diversity in forms of life that have inhabited the earth. It also points to great transformation. Only few organisms that live today, such as horseshoe crabs, have been long present in the fossil record. Most existing species are much more recent appearances. Many groups, such as the dinosaurs, flourished for a span of time and then disappeared. Paleontologists find relationships and discover patterns that suggest that organismic life evolved as part of the evolution of the whole earth.

No doubt, the fossil record is woefully incomplete—how few of the organisms that lived in the past actually left traces of their existence! But when one brings the fossil record into relation to all the knowledge one can gain by studying organisms, ecology, and geology in the present day, quite a rich picture emerges. The incompleteness of the picture can serve as a warning to hold it and the conclusions we derive from it lightly and fluidly. Any picture of evolutionary processes needs to be open, mobile and ready to evolve.

Figure 2. Fossil of a large ancient amphibian, *Sclerocephalus haeuseri*; from the upper Carboniferous (Pennsylvanian) period in Germany. Body length: about 5-6 feet (1.5-1.8 meters). Fossils of frogs appear much later. (State Museum of Natural History, Stuttgart, Germany; Dr. Günter Bechly. https://commons.wikimedia.org/wiki/File:Sclerocephalus_haeuseri,_original_fossil.jpg.)

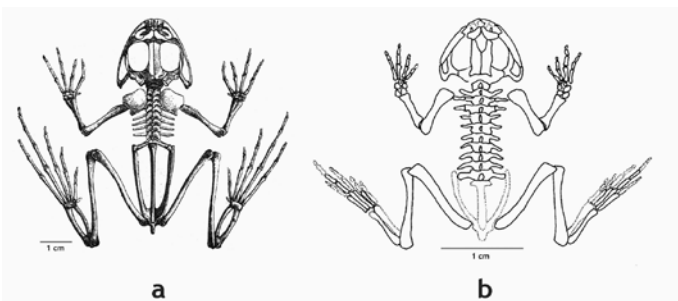


Eon	Era	Period	Epoch	m.y.
Phanerozoic	Cenozoic	Quaternary	Holocene	1.5 23 65 250 540
			Pleistocene	
		Neogene	Pliocene	
			Miocene	
		Paleogene	Oligocene	
			Eocene	
	Paleocene			
	Mesozoic	Cretaceous	250	
		Jurassic		
		Triassic		
	Paleozoic	Carboniferous	Permian	540
			Pennsylvanian	
		Mississippian		
		Devonian		
		Silurian		
		Ordovician		
		Cambrian		
Precambrian	Proterozoic		2500	
	Archean		3800	
	Hadean		4600	

Table 1. Geologic time periods—from most recent (top) to the oldest layers of rock (bottom). m.y. = millions of years (as estimated by measuring radioactive decay in the respective rock layers).

Today there are about 4,800 known species of frogs. Each has its particular characteristics, and it is even possible to identify a species on the basis of a few bones. But all frogs have very similar skeletons and since frog skeletal structure is unique among all four-legged vertebrates (tetrapods), a specialist examining fossil bones or imprints can identify whether they belonged to a frog or not.

Figure 4. a: Modern frog skeleton (common European water frog, *Pelophylax esculentus*); b: reconstruction of a fossil frog (*Viarabella herbsti*) from Argentina, early Jurassic period; c: reconstruction, shown as if jumping, of the currently earliest known fossil frog, *Prosalirus bitis*, from Arizona, early Jurassic period. (Sources — a: https://commons.wikimedia.org/wiki/File:Rana_skeleton.png; b: Roček 2000, p. 1301; c: Shubin and Jenkins, 1995.)



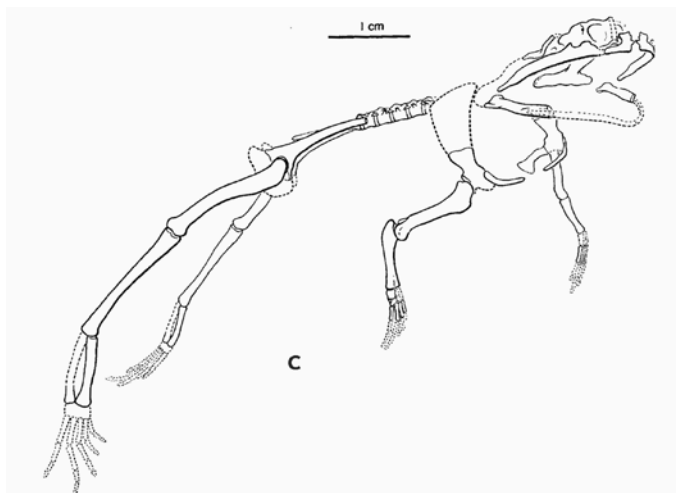
For the most recent periods of the earth's history one finds fossils that can easily be identified as frogs. For example, wood frog fossils have been found in layers of rock in Nebraska (Pliocene epoch of the Cenozoic era) in which fossils of now extinct animals such as saber-tooth cats and stegomastodons (relatives of elephants) are also found. Frog fossils can be found back into the Mesozoic era (colloquially known as the age of dinosaurs) and can be very well preserved (see Figure 3).



Figure 3. Well-preserved fossil frog skeleton (*Liaobatrachus*) found in China, early Cretaceous period. (From Roček et al. 2012.)

In some cases one even finds fossils of tadpoles and partially metamorphosed frogs in one layer (see, for example, Roček and van Dijk 2006).

Figures 4a and 4b show the skeleton of a modern frog and a reconstruction of the skeleton of one of the earliest frog fossils that has been found until now. This fairly complete fossil, given the name *Viarabella herbsti*, was found in Argentina, and all the bones resemble those of modern frogs. The earliest species found up until now that is considered a frog, *Prosalirus bitis*, was discovered in Arizona (early Jurassic period of the Mesozoic era). Figure 4c shows a reconstruction based on three specimens that were found (Shubin and Jenkins 1995). With its long hind limbs, the lengthened pelvis, the presence of the urostyle (which is unique to frogs), and the short body, it is clearly



a frog. It does have some characteristics in the skull and other parts of the skeleton that distinguish it from modern frogs, but not to the degree that one would think it to be a different kind of animal.

So it seems that since the early Jurassic period of the Mesozoic era, the basic frog way-of-being, at least as it is manifest in the skeleton, has hardly changed. As a paleontologist who specializes in amphibian evolution writes, “the basic structural scheme of frogs has been maintained without any significant change, which suggests that an equilibrium between function and structure and the mode of life was maintained” (Roček 2000, p. 1295). (The earliest known salamander and caecilian fossils—the other two groups of living amphibians—are also found in Jurassic layers.)

Before the early Jurassic period, no frog fossils have been found. In older rocks (early Mesozoic and Paleozoic eras back to the Devonian period) one finds many fossils of amphibians, all of which have long been extinct. Both larval and adult fossils have been found, mostly in rock formations that geologists believe formed out of sediments at the bottom of ponds and lakes. While in many cases the fossils superficially resemble today’s salamanders, they also have their own array of characteristics that set them apart from the living groups of amphibians (frogs, salamanders, and caecilians). Figure 5 shows a selection of some of these fossil amphibians, most of which were much bigger (1 to 6 meters in length) than today’s amphibians. There is an astounding diversity of forms, as if nature were experimenting with manifold ways to be an amphibian. But it is evident that none resembles a frog. As eminent paleontologist Robert Carroll writes, “despite the great diversity of Paleozoic and early Mesozoic tetrapods that had an amphibious life history, none shows obvious affinities with the three living amphibian orders. This constitutes one of the largest morphological and phylogenetic gaps in the history of terrestrial vertebrates” (Carroll 2000, p. 1270).

Such “gaps” are popularly called “missing links,” and paleontologists have been motivated to continue to search for fossils that would fill the gaps. There is an expectation of some form of continuum, fossils that reveal a closer connection of frogs (and also salamanders and caecilians) to older amphibians. This expectation is based on the view—which Darwin presented in 1859 so forcefully and cogently in *Origin of Species*—that species evolve gradually out of one another. So paleontologists hope to find fossils that display at least some frog characteristics to bridge the gap between full-fledged frogs and early amphibians. While this hope motivates the search for fossils, it does not generate them, so paleontologists have to live with what they find.

In the case of frogs, a very few connecting fossils have been found. One is *Triadobatrachus massinoti* (from the

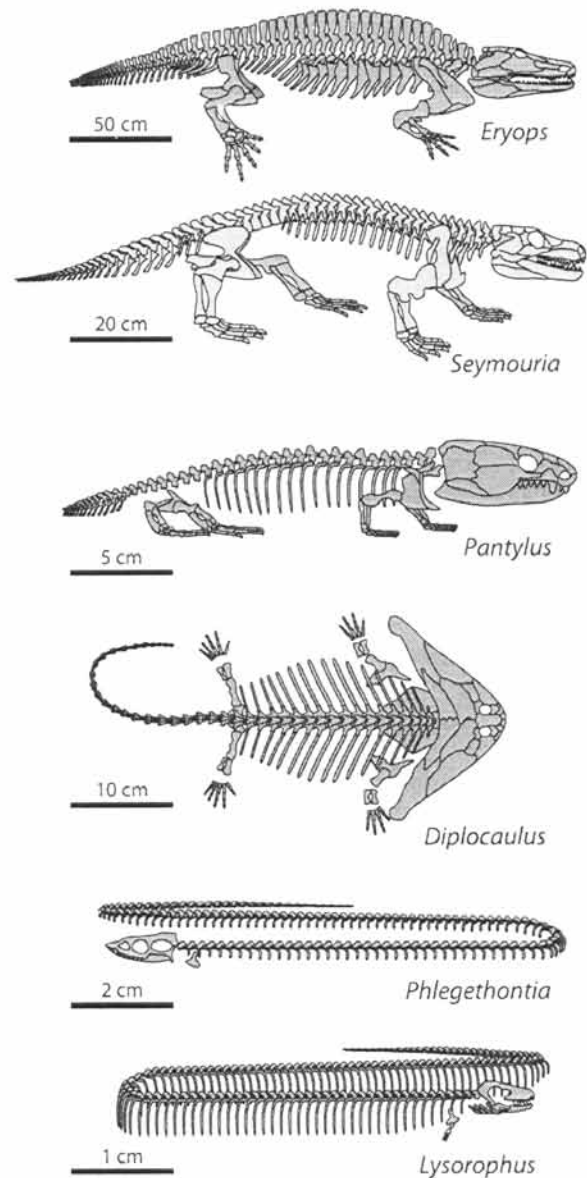


Figure 5. Some examples of the diverse types of amphibian fossils that have been found in the early Mesozoic and Paleozoic eras, before any fossils of the living groups of amphibians (frogs, salamanders and caecilians) are found. Not ordered temporally. (Source: Schoch 2009.)

early Triassic period of the Mesozoic era; see Figure 6 and Roček and Rage 2000). Only one specimen has been discovered so far and that was in Madagascar. The skull is quite frog-like in overall shape and in the configuration of the individual skull bones. In contrast, the body is not frog-like: it has a relatively long vertebral column, ribs, a tail, and the hind limbs are short. In other words, the specializations connected with the present-day frog’s leaping mode of locomotion were not present. There is some lengthening of the pelvis and the vertebral column is shorter than in many other amphibians. So the fossil is morphologically “an intermediate between primitive amphibians and anurans [frogs]” (Roček and Rage 2000).

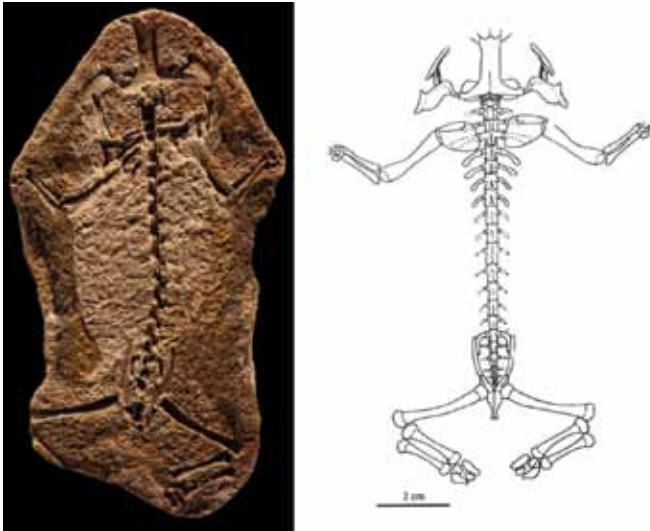


Figure 6. *Triadobatrachus massinoti*; amphibian fossil from the early Triassic period. Left: Fossil imprint; right: reconstruction. (Sources: imprint from Musee d'Histoire Naturelle, Paris; reconstruction from Roček and Rage 2000.)

Pelvic lengthening and characteristics of the sacrum in another fossil, *Czatkobatrachus polonicus*, show greater resemblance to frogs, but no skull bones have been found and otherwise it shows little resemblance to frogs. *Czatkobatrachus* was found in Poland and in somewhat younger layers than *Triadobatrachus* (Evans and Borsuk-Bialynicka 2009; Roček and Rage 2000).

Some substantially older fossils from the lower Permian period of the Paleozoic era do not resemble frogs, but they do have a few frog-like characteristics that only a paleontologist with highly specialized knowledge would recognize. One example is in *Doleserpeton annectens* (from Oklahoma, figure 7a). Its most frog-like characteristics, as in *Triadobatrachus*, are in the skull: the characteristic (pedicellate) tooth form of modern amphibians (which distinguishes them from most extinct groups of amphibians), the structure of the palate, the stirrup (stapes) in the middle ear, the inner ear, and features of the braincase. Otherwise it resembles other extinct four-legged creeping amphibians and is more like a salamander in overall form than a frog. *Gerobatrachus hottoni* (from Texas, figure 7b) has, in contrast, a more compact form; it has a broader, more frog-like skull shape and also a shorter spine. It too has pedicellate teeth. Both of these species, unlike the many larger ancient amphibians, are in the size range of modern amphibians.

So in these older layers there are traces of “frogness” but they are present in different species that as a whole were uniquely configured. “Frogness” with all its features does not appear all at once or in only one lineage in the fossil record.

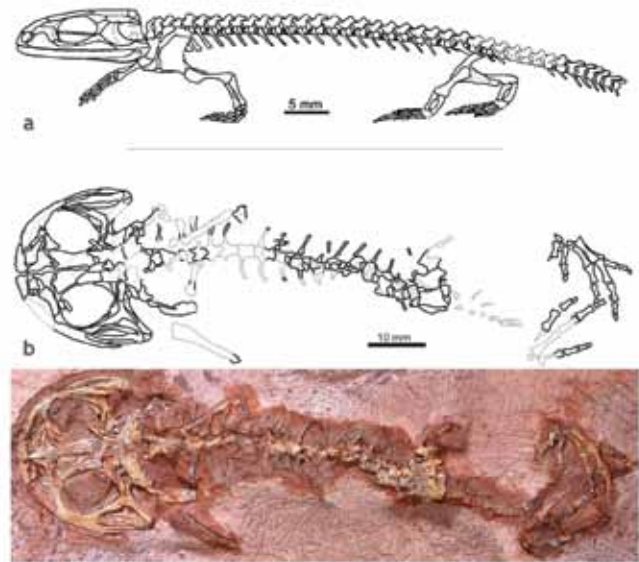


Figure 7. a: *Doleserpeton annectens*; amphibian fossil found in Oklahoma, lower Permian period. Body length: approx. 5.5 cm (2.17 inches); b: partial reconstruction and photo of fossil of *Gerobatrachus hottoni*, amphibian fossil from the lower Permian period, found in Texas. Body length: approx. 11 cm (4.3 inches). (Sources – a: Sigurdson and Bolt 2010; b: Anderson et al. 2008.)

Going back still further, paleontologists continue to find amphibian-like animals. They represent the first four-legged (tetrapod) vertebrates in the fossil record. Some of the earliest tetrapod vertebrates, such as *Acanthostega* (see Figure 8a), also have fish-like characteristics. These include bony fin rays in the tail, evidence of a lateral line organ, and evidence of internal gills. As paleontologist Jennifer Clack (2006) writes, “If one were to imagine a transitional form between a ‘fish’ and a ‘tetrapod,’ *Acanthostega* would match almost exactly those expectations.” The detailed anatomy of the four limbs does not suggest that those limbs could support walking on land; more likely they were used as swimming paddles (Clack 2012). This indicates that the seemingly logical and often-presented notion that four-leggedness (tetrapod limbs) in vertebrates developed as an adaptation to living on land isn’t valid. Tetrapod limbs apparently developed first in water and were only in later forms used for moving on land.

The lobed-fin fish *Eusthenopteron* is a vertebrate fossil from the Devonian period that predates any tetrapods (see Figure 8b). Although clearly an aquatic-dwelling fish, it has certain structures in common with the tetrapods that arise later. Most striking is the internal structure of the fins: the body-near parts of both the pectoral and pelvic fins consist of three bones each; they correspond, in the pectoral fin, to the humerus, ulna, and radius in the forelimb of a tetrapod and, in the pelvic fin, to the femur, tibia, and fibula of the hind limb of a tetrapod. The arrangement of some of the

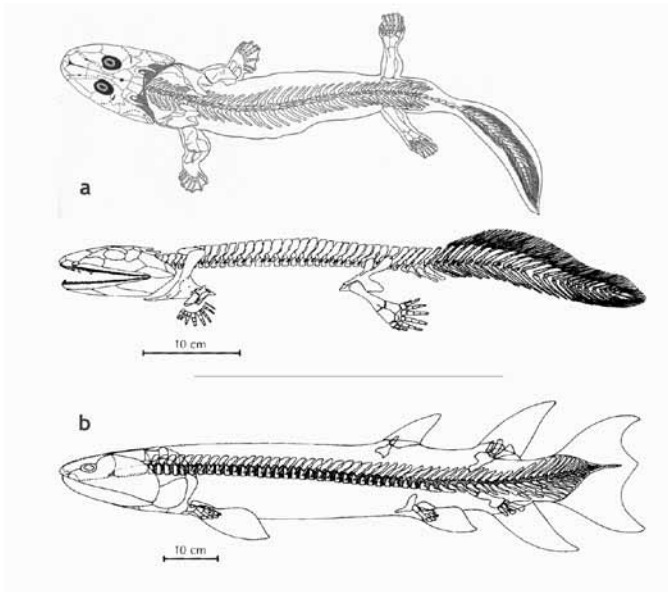


Figure 8. a: *Acanthostega*, a fossil from the late Devonian period that exhibits both amphibian and fish characteristics; see text. b: *Eusthenopteron*, a lobed-fin fish fossil from the Devonian period; see text. (Sources – a, top: Clack 2012, p. 165; a, bottom and b: Carroll 1997, p. 300.)

skull bones as well as the presence of internal nostrils are also similar to subsequent tetrapods.

Fishes represent the first vertebrate animals to appear in the fossil record. This is as far back as I want to go—back to the “age of fishes” when manifold types of fishes populated the waters of the earth and no fossils of amphibians, reptiles, birds, or mammals are found.

Forming a Picture of Evolutionary Transformation

From the fossil record we can know that frogs have been a creative presence on earth for a long time. We find frog fossils back into the early Jurassic period of the Mesozoic era. Many species have arisen and passed away since then, but “frogness,” the order “anurans” in scientific terms, has remained present. The diversity of frogs increased over time, and today’s variety, as expressed in 4,800 species, shows the many wondrous ways of being a frog that have evolved.

In earlier layers there are no frog fossils. The first frog fossils have virtually the same proportions and the same skeletal morphology as today’s frogs. So since the early Jurassic, the highly specialized and unique morphology of frogs has remained remarkably constant. Interestingly, something similar happens in many animal and plant groups. As Robert Carroll (1997) writes, “Instead of new families, orders, and classes evolving from one another over long periods of time, most attained their distinctive characteristics when they first appeared in the fossil record and have retained this

basic pattern for the remainder of their duration” (p. 167). So paleontologists find periods of fundamental shifts in morphology during which new groups appear and these are followed by long periods of time in which the groups diversify, developing variations on a theme.

But there are also rare and interesting transitional forms. Before there are full-fledged frog fossils, *Triadobatrachus* and other fossils exhibit some few features—mostly ones in the head—that later all frogs possess. These animals were a far cry from frogs, but if you know frog morphology well, you can see hints of what is to come. Of course, you could never predict, by knowing *Triadobatrachus*, that frogs would appear later.

What is also typical in the fossil record is that the hints or foreshadowing of what will come later are not manifest in only one type of fossil, but in several. Various elements of what appears later in the new group are manifest in earlier periods, but in different species. Evolutionary scientists often speak in this connection of “mosaic” evolution, since various characteristics appear in different arrangements in different organisms.

In some groups of plants and animals, paleontologists find more transitional forms than in others. But even when a trove of fossils is available, such as in the horse family (Equidae), it is not the case that they line up in a neat series. Rather, there is surprising diversity in the forms that predate modern horses (McFadden 1999). Evolving features appear in different lineages. This is also vividly visible in human (hominid) fossil history; the more fossils we find, the less straightforward the emerging picture of the evolving human form becomes. (See, for example, Lordkipanidze et al. 2013.)

If we consider this feature of the fossil record from a bird’s eye perspective, it is as if we are seeing hints of what is to come spread out in various earlier forms, which then become extinct. Eventually new forms appear, sharing characteristics with various earlier forms but in a new configuration that could never have been predicted on the basis of what came before.

In the Mesozoic and late Paleozoic eras there was a great diversity of amphibians, but only the relatively late appearing frogs, salamanders, and caecilians survived to the present. Among the extinct amphibians, paleontologists find the first four-legged vertebrates (tetrapods) in the fossil record. Just as amphibians today are beings that thrive at the interface of water and land, so the earliest amphibians were four-legged but lived mostly in water. These early tetrapods are preceded in the fossil record of vertebrates by a plethora of ancient fish. Hints of the tetrapod future can (in hindsight) be found in the group of lobed-fin fish. They possessed, as we have seen, a bone structure in the fins that can be viewed as the first beginnings of four-leggedness.

Such phenomena in the fossil record present a picture of major transformation. Manifold new ways of being in the world come to manifestation. This is phylogenetic transformation. Today we find radical organic transformation only in individual development—in embryonic development or in the metamorphosis of the tadpole into the frog. Today frogness “becomes flesh” in each generation of frogs, while during the earth’s history there was a span of time in which frogness became flesh (and sometimes fossilized in rock!) in the stream of then existing vertebrate life. As individual development is an act of creation, so is evolutionary history a record of creativity writ large.

Over the long ages we have been discussing, evolution was occurring with myriad types of organisms. Different ways of being came into appearance—all the kinds of microorganisms, plants, and animals. Since every organism is connected with others in the realization of its life, we need to think of organisms as interpenetrating fields or centers of activity that are in turn influencing and being influenced by the whole ecology of the earth. The fossil record reveals the earth evolving as a whole. It presents traces of a global process of creative transformation.

The Problem of Ancestors

You may have noticed that I have not used phrases such as: “Frogs evolved out of primitive amphibians.” Or: “The first amphibians evolved out of lobed-fin fish.” Why not? First, because such formulations are speculations. While I can observe today how a frog develops “out of” a tadpole, a similar observation is not given through the fossil record. Second, and more importantly, such formulations overlook at an evolutionary scale precisely what is overlooked today at the scale of individual development when we say that a frog develops out of a tadpole. Yes, a frog does come from a tadpole inasmuch as we are looking to the past (physical continuity of life) and the constraints it presents for further development. But the other side of the coin is that the frog is something new in relation to the tadpole; we can’t understand the adult by examining the tadpole. In every developmental process something new is being created.

When we look at evolution, we can find morphological and other connections between new types of organisms and those that came before them. Frogs are clearly connected in the stream of evolution with early amphibians and, prior to that, ancient fish. We can speculate about possible constraining effects of earlier forms on later ones. But the appearance of new forms shows that such constraints must have been radically overcome in the creation of the new. And that is the case in every group of evolving organisms.

It is well worth noting that in evolutionary research there is a strong drive to identify a particular fossil species that can be labeled as the ancestor of a subsequent group: “Most paleontologists look for ancestors—an ancestor-descendant sequence in which ancestors are assumed to be generalized in a particular character, and the descendants more specialized” (Duellman and Trueb 1994, p. 425). One hopes to find ancestral forms that are general enough to evolve, say, into both frogs and salamanders. But there’s a problem here, which is vividly alluded to by Alfred Romer, a great 20th century paleontologist: “After all an animal cannot spend its time being a generalized ancestor; it must be fit for the environment in which it lives, and be constantly and variably adapted to it” (Romer 1966, p. 25).

All fossils reveal variously specialized animals. If a fossil has characteristics of frogs already, then it is not the ancestor one is looking for, since it is already showing frogness. But if a fossil shows no frogness, then how should we determine whether it is a frog ancestor or the ancestor of some other creature? It can’t be done. As vertebrate paleontologist Robert Carroll writes, “If all relationships are established by the recognition of shared derived [i.e. specialized] features, ancestors cannot be recognized as such because they lack derived traits that are otherwise thought to characterize the group in question” (Carroll 1997, p. 152).

Recognizing the impossibility of determining fossil ancestors, scientists who practice so-called pattern cladistics have set themselves a more modest goal (Brady 1985 and 1994; Williams and Ebach 2009). They simply try to establish relationships between forms: those forms are most closely related to each other that share the greatest number of specialized (“derived”) characteristics. These researchers try to construct dichotomously branching diagrams that express greater and lesser relationship in the context of time. They do not speculate—when they stay true to their principles, which is not always the case—about which forms evolved from which. This is a positive development inasmuch as it restrains speculation and focuses attention on relations and patterns that actually can be observed and discerned by comparing fossils. Problematic, however, is the tendency to dissolve organisms into collections of individual specialized traits and solely on this basis to establish relatedness that is supposed to underlie the evolution of real-life cohesive organisms.

It nonetheless remains a common practice in paleontological and evolutionary (phylogenetic) publications to speak, in relation to closely related groups of organisms, of their “last common ancestor” (LCA). So, for example, in the study of human evolution, the chimpanzee (or its close relative, the bonobo) is considered, in respect to morphology and genetics, the closest living relative to human beings

within the animal kingdom. If these two types of beings are closely related today then one expects them to be closely related in evolutionary terms. They must have had a common ancestor. And since the focus is on the continuous stream of physical connectedness through generations, then the conjecture is that there must have been a species that over time differentiated into two different lineages that became, respectively, humans and chimps. If this was the case, then there must have been a “last common ancestor” for humans and chimps. It must have been a real species and theoretically it could be found in the fossil record. Such is the train of thought that motivates the search for ancestors in the fossil record.

The construct of the last common ancestor for any pair of organismal groups seems to be a placeholder for the conviction that there is a branching evolutionary stream that connects all organisms that lived in the past with the living ones. The conviction of the connectedness of all life and its continuity back into the past means that organisms did not evolve out of nothingness, but out of past life forms. This seems reasonable.

But what does “out of” mean when we restrain the tendency to speculate and refuse to view the past as fully determinative of the future? That is the critical question. If I say that humans evolved out of ape- or monkey-like ancestors (or amphibians out of fish ancestors) and if I mean that humans are further evolved monkeys, or amphibians are further evolved fish, then I am forgetting that specifically human characteristics cannot be derived from monkeys, nor can amphibian characteristics be derived from fish. In both cases new qualities emerged in the stream of evolution that cannot be explained by the past. We miss the creative nature of evolution when we only look at it as a changing and re-arranging of existing material.

There is a strong tendency to conflate building up a picture of the continuity of life in evolution with the question of origins. This tendency manifests itself when evolutionary scientists continue to speak of and to search for ancestors. “An ancestor is, by definition, plesiomorphic (primitive) in every way relative to its descendants” (Cartmill and Smith 2009, p. 62). “Primitive” means, strictly speaking, that it does not have the specialized characteristics of its descendants. But, as Romer pointed out, every species one finds in the fossil record is in its own ways specialized. It is in this sense neither “primitive” nor “generalized,” which is what one implicitly assumes the ancestor to be. So the search for ancestors is the futile search for fully developed organisms that also should somehow indicate that they have potential for further evolution.

The futility shows itself inasmuch as scientists usually end up recognizing that purported missing links or

ancestors are too specialized in one way or another to fit the vaguely held notion or expectation of an ancestor. For example, Romer designates an apparent prime candidate for a tetrapod ancestor as being “a bit off the main line” due to its unique specializations (Romer 1966, p. 88). It is altogether clear: biologists work with conflicting and unclear ideas in their search for ancestors that are meant to pinpoint origins.

Thinking About Origins

The quest for ancestors reflects a deep longing to understand origins. It contains, at least implicitly, the question: Where do we come from? The problem is that the quest has been channeled into a vain search for a physical origin that lies in the past. Scientists have been searching for origins in the wrong place and therefore never find what they are looking for. As strange as it may sound, you cannot discover origins by looking to the past alone.

This is the lesson we learn in the phenomenological consideration of organismic development as we observe it today: at any stage of life an organism is both past (what has become) and activity that brings forth something new. The organism as activity or agency is not some thing in space, some trait or characteristic that you could place next to its skin or stomach. It is the being-at-work in all the features of the organism. It is not something we can directly perceive as an entity. It is what shows itself to the mind’s eye as we follow a developmental process from embryo to adult. It shows itself when we study the way an organism manifests plasticity by “being itself differently” as conditions vary. It shows itself when we compare one type of organism with others and we begin to see its special way of being reflected in all its features.

Evolutionary origins must be creative, capable of bringing the new to appearance. We cannot understand evolution by focusing only on entities that have already been brought forth. Rather, we must follow processes and see connections. The creative and originative is spread out everywhere in the living world and has left its traces in the fossil record. But whether we are able to see it depends on how we look.

We cannot derive the frog from earlier amphibians, as little as we can derive present-day human beings from the many fascinating antecedent hominid forms. Antecedent amphibian fossils indicate the pathways through which frogness comes to appearance in the fossil record, just as studying the transformation of the tadpole shows us how the adult frog comes to appearance. Every new fossil discovery can enrich our growing picture of the story of frog or human evolution and contribute in that sense to our understanding of origins.

But instead of looking for *causes* in the past—instead

of trying to *explain* evolution through speculative mechanisms—we can shift the focus of research to building up a picture of the immensely creative processes, relations, and patterns that the study of evolution reveals. In one way this is a much more modest undertaking than the attempt to explain our origins as contemporary evolutionary science does. But this undertaking is at the same time demanding. It calls for recognizing and holding back speculation; it calls for our thinking to stay close to the phenomena and to glimpse the reality speaking in the patterns and connections. A deeper understanding of evolution will evolve to the degree that human consciousness evolves. Gathering more facts can be important, but developing our minds to allow more to reveal itself within the field of facts is even more essential.

With the evolutionary appearance of humans on earth and subsequent historical and cultural evolution, beings have arisen who are in a position to consider their own evolution and the evolution of the whole planet. We can study and ponder the evolution of all our fellow creatures on earth and of the earth itself. This is a characteristic that we do not find in the rest of organic life. It is a unique quality of human evolution that we arise as beings who can study and begin to understand, through thoughtful observation and contemplation, the evolving world of which we are a part and in which we participate.

This simple fact has implications that are all too easily overlooked. They have to do with origins. We can only study something that we have a relation to. If something were totally foreign, so that our senses and our mind could find absolutely no relation to it, then it would not exist for us. But we can engage with and study all life on earth. As different as we are from bacteria, mosses, or dragon flies, we do perceive them. We find characteristics that we have in common with them and many others that we don't share. All this is evidence of the fact that we are deeply and broadly connected with the totality of life on earth. This means that bacteria, plants, and animals are part of us. Certainly, in one sense we are separate beings, but as living and thinking beings we encompass all other life.

We speak today often so glibly of the interconnectedness of all things, imagining separate entities and processes that are connected as in a web or network. But once we begin to understand interconnectedness more deeply, we realize the limitations and misleading nature of an image that begins with separateness and only secondarily establishes relations.

From the perspective of the fossil record human beings as a discrete species are a relatively late appearance. But we can also say that in considering the development of life on earth we are considering our own development. We are intimately connected with the originative forces of evolution.

REFERENCES

- Anderson, J. et al. (2008). "A Stem Batrachian from the Early Permian of Texas and the Origin of Frogs and Salamanders," *Nature* vol. 453, pp. 515-18. doi:10.1038/nature06865.
- Brady, R. H. (1994). "Pattern Description, Process Explanation, and the History of the Morphological Sciences." Originally published in: *Interpreting the Hierarchy of Nature: From Systematic Patterns to Evolutionary Process Theories*, edited by L. Grande and O. Rieppel, pp. 7-31. San Diego CA: Academic Press, 1994. Available online at: <http://natureinstitute.org/txt/rb>.
- Brady, R. H. (1985). "On the Independence of Systematics," *Cladistics* vol. 1, pp. 113-26. Available online at: <http://natureinstitute.org/txt/rb>.
- Carroll, R. L. (1997). *Patterns and Processes of Vertebrate Evolution*. New York: Cambridge University Press.
- Carroll, R. L. (2000). "The Lissamphibian Enigma," in *Amphibian Biology*, edited by H. Heatwole and R. L. Carroll, pp. 1270-73. Chipping Norton, Australia: Surrey Beatty and Sons.
- Cartmill, F. and F. H. Smith (2009). *The Human Lineage*. Hoboken NJ: Wiley-Blackwell.
- Clack, J. A. (2006). "The Emergence of Early Tetrapods," *Palaeogeography, Palaeoclimatology, Palaeoecology* vol. 232, pp. 167-89.
- Clack, J. A. (2012). *Gaining Ground* (second edition). Bloomington IN: University of Indiana Press.
- Duellman, W. E. and L. Trueb (1994). *Biology of Amphibians*. Baltimore MD: The John Hopkins University Press.
- Evans, S. E. and M. Borsuk-Bialynicki (2009). "The Early Triassic Stem-Frog *Czatkobatrachus* from Poland," *Palaeontologica Polonica* vol. 65, pp. 79-105.
- Holdrege, C. (2015). "Do Frogs Come from Tadpoles?" *In Context* #33, pp. 13-18. Available online: <http://natureinstitute.org/pub/ic/ic33/frog.pdf>.
- Lordkipanidze, D. et al. (2013). "A Complete Skull from Dmanisi, Georgia, and the Evolutionary Biology of Early *Homo*," *Science* vol. 342, pp. 326-31. doi:10.1126/science.1238484.
- McFadden, B. (1999). *Fossil Horses*. Cambridge: Cambridge University Press.
- Roček, Z. (2000). "Mesozoic Anurans," in *Amphibian Biology*, edited by H. Heatwole and R. L. Carroll, pp. 1295-331. Chipping Norton, Australia: Surrey Beatty and Sons.
- Roček, Z. and J.-C. Rage (2000). "Proanuran Stages," in *Amphibian Biology*, edited by H. Heatwole and R. L. Carroll, pp. 1283-94. Chipping Norton, Australia: Surrey Beatty and Sons.
- Roček, Z. and E. van Dijk (2006). "Patterns of Larval Development in Cretaceous Pipid Frogs," *Acta Palaeontologica Polonica* vol. 51, pp. 111-26.
- Roček Z. et al. (2012). "Post-Metamorphic Development of Early Cretaceous Frogs as a Tool for Taxonomic Comparisons," *Journal of Vertebrate Paleontology* vol. 32, vol. 1285-92.
- Romer, A. (1966). *Vertebrate Paleontology*. Chicago: University of Chicago Press.
- Schoch, R. (2009). "Evolution of Life Cycles in Early Amphibians," *Annual Review of Earth and Planetary Sciences* vol. 37, pp. 135-62.
- Shubin, N. H. and F. A. Jenkins (1995). "An Early Jurassic Jumping Frog," *Nature* vol. 377, pp. 49-52.
- Sigurdson, T. and J. R. Bolt (2010). "The Lower Permian Amphibamid *Doleserpeton* (Temnospondyli: Dissorophoidea), the Interrelationships of Amphibamids, and the Origin of Modern Amphibians," *Journal of Vertebrate Paleontology* vol. 30, pp. 1360-77.
- Williams, D. M. and M. C. Ebach (2009). "What, Exactly, is Cladistics? Re-writing the History of Systematics and Biogeography," *Acta Biotheoretica* vol. 57, pp. 249-68. doi:10.1007/s10441-008-9058-5.



20 May Hill Road, Ghent, NY 12075

NON-PROFIT ORG.
U.S. POSTAGE
P A I D
GHENT, N.Y.
PERMIT NO. 5

CHANGE SERVICE REQUESTED

PRINTED ON 100% POST-CONSUMER WASTE RECYCLED PAPER

Upcoming Events

Summer Course 2016

Tending the Roots of Sustainability

*The Significance of Experience-based Learning and
Our Responsibility to Children and the Earth*

June 19 – 25, 2016

Our course is designed to nurture connectedness with the wisdom of nature. We tend the roots of sustainability when we inspire children to perceive, to probe, to question; to be astounded by the intricacy of nature; to understand and to value the interconnectedness of all beings and processes.

This means working on developing new capacities. In the course, we will

- Engage in concrete experiences with nature.
- Become aware of and work to break through habits of abstract thought.
- Practice attending to and understanding the dynamic nature of nature.
- Discuss developmentally appropriate ways to connect children to nature.
- Explore the role of cultural activities (story, festivals, and art) in awakening capacities that embody vitality and a sense of connectedness.

The course, which will be taught by Craig Holdrege and Henrike Holdrege, begins on Sunday evening, June 19, at 7 pm and ends on Saturday, June 25, at 1 pm with a potluck lunch.

On Wednesday evening we will have a guest lecture on the course theme by George Russell, Ph.D., editor of the 2014 book *Children and Nature: Making Connections*, co-founder and former editor of *Orion* magazine, and emeritus professor of biology (Adelphi University). This talk will be open to the public.