## CHAPTER 20

# Inheritance and the Whole Organism

In 1923 Wilhelm Johannsen, the Danish plant physiologist and pioneering geneticist who had earlier given biologists the word "gene", expressed concern about the way genes were being conceived as neat, cleanly separable causal units. He made the following curious remark, which remains today as intriguing as ever, despite its never having had much effect on the direction of genetic research:

> Personally I believe in a great central 'something' as yet not divisible into separate factors. The pomace–flies in Morgan's splendid experiments continue to be pomace–flies even if they lose all "good" genes necessary for a normal fly–life, or if they be possessed with all the "bad" genes, detrimental to the welfare of this little friend of the geneticists (Johannsen 1923, p. 137).

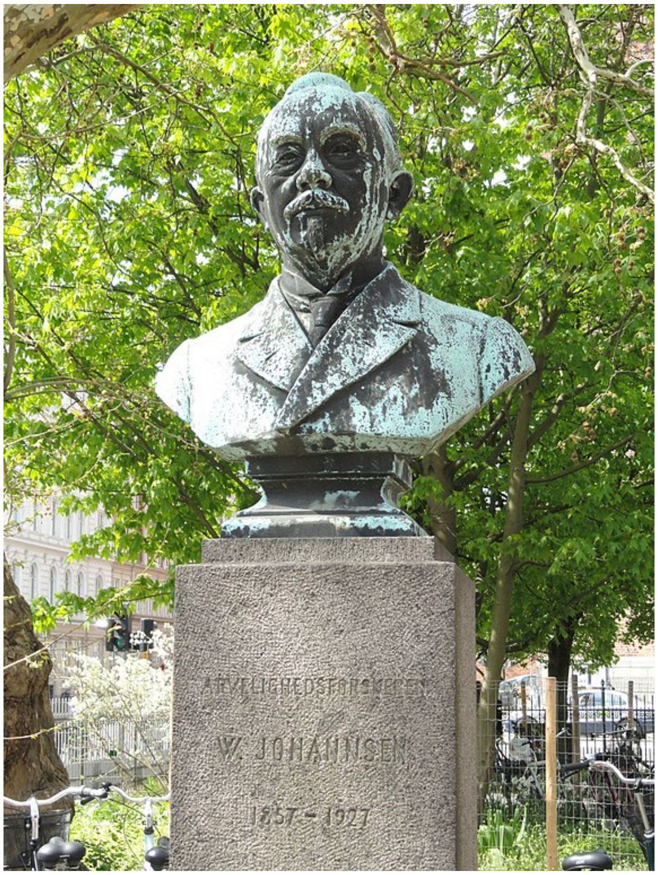

**Figure 20.1**. Bust of Wilhelm Johannsen at the Botanical Laboratory in Copenhagen.[1]

The pomace fly, of course, was the fruit fly (*Drosophila melanogaster*) that Thomas Hunt Morgan, in his Princeton University laboratory, was famously converting into a "model organism" for genetic studies. Thanks to procedures for mutating genes, controlling the mating of the flies, and tracing the inheritance of traits, this was the fateful period during which the word "genetic" was inflating wildly until it swallowed up (among other things) the meaning of "heritable". Oddly enough, the fact that whole cells — and not merely genes — pass as inheritances between generations was progressively losing its significance in the minds of biologists interested in inheritance and evolution.

This violent abstraction of genes away from the whole cell and whole organism was a crime against understanding from which biologists have yet to recover. The evidence of their own bodies should have established beyond doubt that genes do not single-handedly account for biologically and evolutionarily significant features of life. Cells of the human body possessing the same inherited genome differentiate as wholes into hundreds of unique cell types — hundreds of often dramatically different kinds of living things. The differentiation of each cell type along a progressive pathway of coherent, well-directed change extending across successive cell generations, enables the body to form the substance of bone and skin, liver and brain, lens and retina. (See Chapter 17, "Evolution Writ Small".)

Nevertheless, disinterest in this all too obvious and fundamental fact of life took over evolutionary biology as if the disinterest were somehow a prerequisite for the preservation of the discipline. Genes came to be seen as discrete and particulate entities, making them nicely definable and easily trackable, fit to be considered primary causes of the organism.

The consequence for the organism was that it lost its unity, becoming instead an aggregate of discrete parts and traits mapped to genes. Holistic, contextual understanding was severely downplayed. The organism's interior agency became alien to the biologist's manner of thinking — displaced by the informational gene, where the idea of information, with its inescapable connection to meaning, was conveniently conflated with material entities. With the aid of information one could import meaning into biology "under the table", thereby making biological description tolerable, while pretending that one's reference was really only to inherently meaningless matter. And so, as far as explicit theorizing went, the unifying play of organizing idea and intention through all biological activity (Chapter 6, "Context: Dare We Call It Holism?") could no longer be mentioned in decent circles.

On his part, Johannsen realized that the new genetic work, based as it was on the assumed existence of separate and independent causes of traits, left untouched what might easily be seen as the central problem of inheritance: the faithful reproduction of kind, or type — that is, the maintenance of the materially perplexing, integral unity that harmonizes all the particular traits and parts of an organism and expresses a species' characteristic way of being. While mutated genes might result in (typically pathological) *differences* in certain narrowly conceived traits, this sort of change never reached through to the fundamental identity ("that great central something") defining an organism as *this kind* of organism. Whatever the artificially induced and disfiguring mutational horrors, the pomace flies always remained pomace flies.

Johannsen's problem arises because we can hardly help recognizing the distinctive unity of a living being — a unity we cannot equate to any particular parts. Rather, the unified whole seems in some way *responsible* for its parts which, in turn, always appear to be *expressions* of the whole. We never see an organism being constructed or assembled from already-existing parts. In its development it works to bring them about — to differentiate them out of a prior and continuing unity. Every organism is the power to do this work, and the power is not derivable from its material results. If some of its parts become deformed, the organism works out of its unity to compensate for the deformities as best it can, doing so according to the way of being of its own kind.

## E. S. Russell picked up Johannsen's problem

But what sort of genetically investigated *differences* was Johannsen dismissing as disconnected from the problem of the whole? In his brilliant, and still decisively relevant[2] 1930 book, *The Interpretation of Development and Heredity*, the British marine biologist E. S. Russell took up Johannsen's concern. "When we say that a child shows a hereditary likeness to its father", Russell wrote, "we mean that it resembles its father more closely than it does the average of the population. *The likeness is observable in respect of those [rather incidental] individual characteristics that distinguish the father from the rest of the race"* (emphasis added).

Much the same can be said of the child's resemblance to its mother. It's also possible that there will be no particular resemblance to either parent. "But yet in all three cases the child would show the characteristics of its species and its race — it would be a human child, distinguishable as belonging to the same racial type as its parents". As Russell then noted, this general resemblance in type, whereby all members of a species *share* an entire manner of development and way of being, can hardly be understood by referring to the inheritance of this or that variation wherein a parent happens to *differ* — although not in its central identity or type — from most other members of the same species. But such incidental variations have been a main focus of geneticists' investigations for the past century.

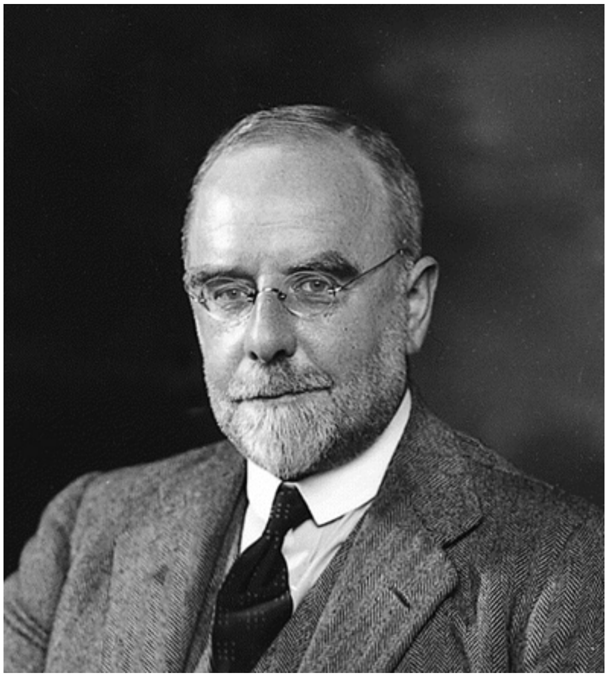
**Figure 20.2**. E. S. Russell.[3]

In general, isolated "characters" — for example, the color of a pea or of an animal's eyes — are much more easily assessed and compared in two similar organisms than are the *characters* of two whole organisms of different types. The usual genetic breeding experiments that compare differences in isolated traits of closely related organisms can hardly be applied to the different natures and ways of being of an antelope and a bison — let alone an eagle and a pig — if only because the fact of infertility between fundamentally different types renders routine experimental inter-breeding impossible in such cases.[4]

And so biologists have long been forming their idea of heredity against the backdrop of carefully selected, inessential, experimentally accessible traits that scarcely touch the problems presented by every organism's essential unity and inalienable character. They have not been asking themselves, "How can we begin to think about the *organizing power* by which a mammal differentiates and maintains in its proper place the indivisible uniqueness of a whole liver cell (and every one of its billions or trillions of other cells) as long as it is needed?"

The distinction between a fundamental, shared nature, on one hand, and individual peculiarities incidentally distinguishing organisms sharing that nature, on the other, has practical implications for genetic research:

> The broad general resemblances of type give no hold for experimental or statistical treatment, and have accordingly on the whole been ignored. But it is this *general* hereditary resemblance which constitutes the main problem. [The gene theory] deals only with *differences* between closely allied forms, and with the modes of inheritance of these differences; it leaves the main problem quite untouched as to why, for example, from a pair of *Drosophila* only *Drosophila* arise. It takes for granted the inheritance of Johannsen's "great central something" — the general hereditary equipment of the species (Russell 1930, pp. 269-70).

Every organism is thoroughly holistic (contextual). Its entire business might be seen as the continual, total reorganization of its own part-relations, or causal interactions, in response to different environments — all in harmony with its own essential way of being. Given this organization, harmony, and unity of being through which the organism's central, governing character is expressed, it seems perfectly reasonable to surmise that this character could never be dissected or analyzed into a sum of causal relations between separate parts. Rather than being causal in the sense of "resulting from the impact of discrete thing on discrete thing", the organism's unity is an intimate interweaving, a participation of one part in the very being of another.

In sum: genetic analyses, in which we try to isolate the effects of specific genes, do not seem to be bringing us nearer to understanding the mystery of why pomace flies always remain pomace flies. The key issue here concerns the distinction between, first, individual features of an organism imagined as discrete and more or less separable parts (traits or "characters") somehow thought to be *caused* by particular genes; and, second, the integral unity whereby every cell and organism exists and functions as a whole, employing genes and all other resources according to its own, well-organized purposes.

## The problem of the whole

The earlier parts of this book have provided the necessary basis for apprehending the wholeness of organisms. We will briefly review a few of the relevant understandings. In Chapter 6, for example, we looked at how, in contemporary biology, we hear over and over that one or another molecular process in an organism is “context-dependent” — albeit without anyone paying attention to what “context” means. What escapes notice is that the appeal to context is always an appeal to the governing *ideas* that make the context a coherent reality — make it what it is. Without a specific set of ideas, we don’t know whether a game board is a checker board or a chess board, which provide very different contexts for play. In the same way, a quiescent cell and a dividing one give entirely different meanings to the “play” of the cell’s constituent molecules.

I also noted in Chapter 6 how the reference to context-dependent processes suggests that there must be causes running from the larger context, or whole, to one or another local part. But the starting point of the “causal arrows” in such a case would have to be *everywhere*, which makes no sense in terms of our usual causal notions. If the arrow cannot be spatially located, it’s because what we’re trying to get at is not a link in a physical causal chain, but — consistent with the role of ideas in establishing a context — something more like a possible implication of a broad understanding. We’re looking at the intelligible structure of an unfolding play of meaning, not the mechanistic structure of an array of point causes. How unfolding meanings will proceed into the future is never exactly predictable — no more than the precise outcomes of good stories are predictable. Stories generally *make sense*, and to that degree they are predictable. But they can also have an element of surprise. The perfectly predictable, almost by definition, can never be surprising in the same way.

If a cell manages to eject or degrade a certain toxin, it may be, for example, because in one way or another the toxin threatens the cell’s health or viability. And if the cell initiates expression of a certain gene, it may be that the gene is associated with a regulatory product that will aid in the production of a protein needed for a journey of differentiation the cell has just now entered upon. Neither the threat in the one case nor the need in the other is a specific force or physical factor directly producing the cell’s response. Physical things do not participate in stories where threats or needs can be felt.

In all living circumstances we will sooner or later discover a coherent set of physical connections “explaining” events. But if we look only at that level of explanation, we will never see the meaningful story that is going on. We will not see that this cell is dividing, or that cell is engaged in apoptosis (“committing suicide”), or this other cell is entering a process of differentiation. Local causal arrows — arrows specifically anchored at both ends — make no reference to the division of a cell, which is a fact of the whole.

That’s why, as I mentioned in Chapter 2, death is not a recognizable event from the strictly physical point of view. The physical aspects of molecular interaction in an organism’s tissues continue on uninterrupted after death. Of course, a purely physical, causal sequence is meaningful in its own terms. The question is whether we want to understand events fully, in all dimensions of their meaning.

Then, in Chapter 11, we saw that there is no explanation for the *form* of organisms that is not itself a consideration of form. Form can meaningfully be understood only in terms of form. This is because form is a principle of explanation *above* the physical, a principle pertaining to wholes. Just as the fact of death could never appear in a purely physical description, neither could the loss of form. The form of an organism belongs to the intelligible and holistic *idea* of the organism. Any supposed physical explanation of form is either itself a principle of form (that is, it is not really just physical), or else it doesn't connect with the form it is intended to explain.

And in Chapter 12 we were given three case studies illustrating what it might mean to have a *qualitative* science — which is to say, a science that is a kind of photographic negative of the science we currently have, which has rejected (or, at least, claimed to reject) all qualities. Qualities lead us upward toward the whole, since the qualities of a part become what they are only in light of their participation in the whole. We saw in that earlier chapter how the dominance of retractor muscles lends to the sloth a quality that gains its fuller meaning only in light of the animal's slowness, passivity, plant-like nature, and receptivity to its environment.

I have also commented more than once about the almost universal use by biologists of "organize" / "organizer" / "organization", pointing out that, without reference (implicit, but central) to organizing *ideas*, these words are void of content. Without governing principles of organization, there is no organizing going on. We call something "disorganized" when we cannot detect an ordering idea or meaning in the arrangement of its parts.

*Idea*, *form*, *quality*, *organize* — these words, so crucial for biology, all point to the interior, mind-like aspects of the organism. (We could also cite words like *intention*, *purpose*, *consciousness*, and *agency*, which are showing up ever more insistently around the periphery of biology today.) Such words testify to a reality that cannot be reduced to discrete, thing-like elements standing side by side and relating only externally.

Ideas in general, including those of form and organization, tend to interpenetrate and blend into each other, as is shown by the words of a human language, which are so strongly shaped to their context. This interpenetration of "idea-soaked" parts is essential to the unity of every organic whole. Much the same goes for qualities. It is well-known, for example, that our seeing of one color is strongly affected by the colors around it. The influences of colors are not rigidly delimited, which is why the colors of a painting can participate in, and reflect in themselves, the character of the whole work.

Actually, *all* interior contents, including feeling, intention, and will, seem strongly marked by this character of interpenetration. And this is a decisive fact when we are trying to come to terms with the unity and wholeness of organisms. A mere aggregation of physical *things* never makes for an organic, unified whole. If we are thinking of a whole, it is because, consciously or unconsciously, we have formed an idea of the character of a thing, and it is this idea that supports the meaning of wholeness. Or it might be that the qualities inherent in a thing and all its parts blend together (as in a well-executed painting) so as to give a powerful impression of a unified whole.

If it's true that the unity of an organism derives from its interior being, and if this unity is maintained across generations, then it doesn’t make much sense to try to understand heredity solely in terms of the transmission of physical things. The power by which an organism holds itself together as a meaningful whole cannot derive from one of the parts held together. This helps us to understand why biologists can hardly help themselves when they make so much of the *informational* significance of DNA.

This is one of the ways they make their theoretical position tolerable by importing meaning “under the table”. But, unfortunately, the reality of an interiority that could truly render the idea of information meaningful has never taken root in biological thought. And, in fact, it seems clear that biologists typically see in DNA only the molecule as physically and chemically understood, not the play of organizing ideas and meanings through which the molecule comes to exist as a functionally useful entity.

Biology is not yet ready to accept the reality of the organism’s interiority, and therefore is not ready to take on the problem of wholeness and its implications for heredity and evolution. And that is where we must leave the matter, except for this final thought from Russell: the performance of a whole organism “can be [hereditarily] transmitted only by a whole, i.e. by the egg in its entirety, which already at the very beginning of development *is* the new individual” (Russell 1930, p. 283).

Wholes are *in fact* the only things ever inherited. Their importance for heredity is given right before our eyes. But we don’t seem to know what to do with it.

To conclude the chapter I will look at one way in which holism has figured in current biological thought. This has to do with how the seeming intractability of the problem of wholeness from a conventional and thoroughly non-holistic viewpoint has been used in attacks against the very idea of holism in biology.

## *Is holism incompatible with evolution?*

In 1978, and again in 1985, Harvard geneticist Richard Lewontin wrote that adaptive evolution is possible only if traits and trait variants are *quasi-independent*. That is, if evolution of a trait is to occur, it must be changeable (subject to mutation) in at least some ways whereby the mutation does not dramatically alter other traits. This is, he said, because the incidental alteration of other traits is very likely to harm the organism.[5]

Think of it this way. The vast majority of mutations in organisms are thought to harm the organisms’ fitness. If, then, organisms are so thoroughly holistic that any beneficial mutation in one trait will change (mutate) many other traits, the mutation’s beneficial effect on fitness, so the thought goes, will likely be overshadowed by the negative effects of all those other changes. And so evolution in the direction of greater overall fitness would require a highly improbable number of secondary, beneficial mutations in order to counteract the deleterious “side effects” of the original beneficial mutation. But if traits and their variants are quasi-independent — not incurably holistic — they can, at least some of the time, undergo beneficial mutation without carrying in their train countervailing and damagingly large side effects. These changes could then become part of the evolutionary record.

The relation of parts to whole in biology is a subtle and difficult matter, mainly because the issue is generally treated in a materialistic way, which ignores the dynamic essence of the matter. I will return to this briefly in the next section. But my immediate concern has to do with how Lewontin's "quasi-independent" criterion has been picked up by others in order to make jabs against the idea of holism. The Australian philosopher Kim Sterelny, for example, has written that "It is hard to change developmental sequences if the development of any characteristic is linked to the development of many characteristics. For a change is likely to ramify, having many effects on the developed phenotype, and some of these are nearly certain to be deleterious":

> Thus, to the extent that development is holistic, the more complex the organism, and the more it has been elaborated over evolutionary time, the less significant further change there can be in that lineage. The point that adaptive change would be impossible if development were holistic has been made before. Lewontin, for example, has pointed out that such change requires traits to be "quasi-independent" … (Sterelny 2001).

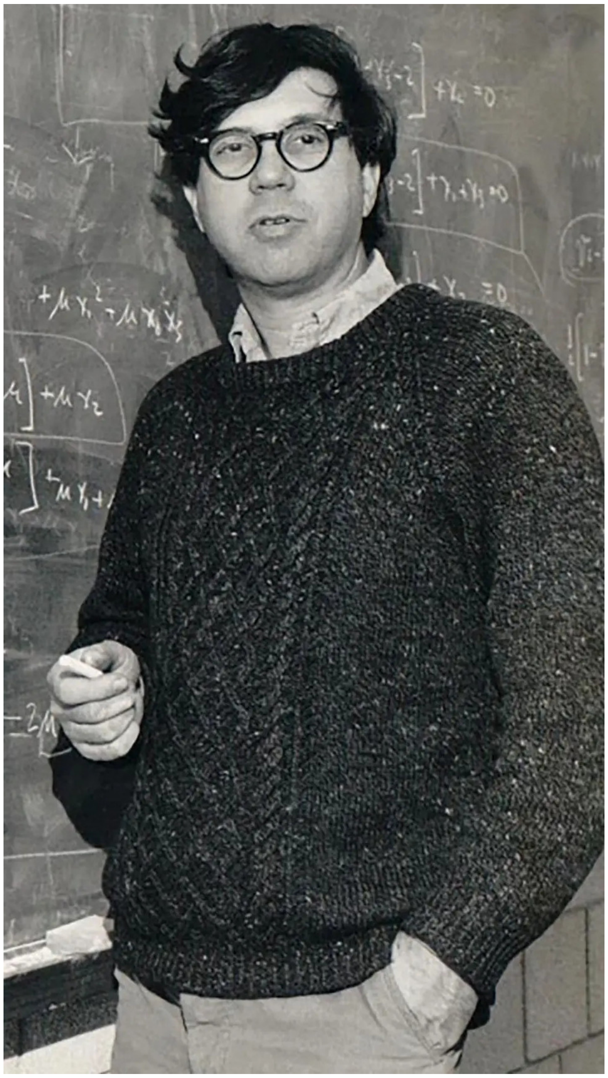

**Figure 20.3**. Richard C. Lewontin.[6]

But there is something strange here. The argument starts by assuming that, in holistic organisms, the effects of a trait change are likely to conflict with each other and be unhealthy. In other words, the assumption is that organisms *cannot* function (with respect to the assembly of inheritances) integrally, coherently, and holistically. But if this is the starting assumption, then there is only brute assertion and no argument at all. The argument, such as it is, becomes possible only *because* of this assumption that organisms cannot really adapt in a holistic manner. And it overlooks the interior wisdom through which all the cell lineages in humans and other multi-cellular species are, amid unfathomable complexity, orchestrated into a harmonious and intricately differentiated whole where accidents, injuries, and unexpected circumstances are commonly overcome.

So we haven't heard much of a case against holism — especially given how often it is admitted that we don’t presently have the tools (let alone the inclination) even to begin investigating the possiblities of holistic inheritance and evolution. As Lewontin himself put it:

> If a change in a trait as a solution to one problem changes the organism’s relation to other problems of the environment, it becomes impossible to carry out the analysis part by part, and we are left in the hopeless position of seeing the whole organism as being adapted to the whole environment (Lewontin 1978).

However hopeless we may feel, the truth of our observations remains. If an organism’s life and development is in fact holistic, why should we suddenly lose sight of this holism as soon as we turn our attention to its management of traits, genetic mutations, and inheritance, or its participation in a species-wide pattern of evolutionary change?

Why, for example, should we ignore the fact of an organism’s future-oriented, holistic capacities when it comes to the preparation of a coherent inheritance for its offspring. Least of all should we ignore this when we consider an organism invested (as described in Chapter 19), with the directive intentions at work in an ongoing, complex, multi-lineage evolutionary process. And why should we lose sight of the developing organism’s remarkable capacity to integrate and reconcile as far as possible its various physical resources — or, for that matter, the even more stunning capacity of two gametes to organize their separate lineage inheritances into a single, viable zygote with new possibilities of life?

When Lewontin spoke of quasi-independence, saying a trait must be changeable (subject to mutation) in at least some ways that do not dramatically alter other traits, he was apparently accepting the particulate view of inheritance and the random view of mutations.[7] He therefore overlooked the possibility that an organism caught up in the evolving destiny of its kind might, by virtue of that very fact, be capable of *coordinating* the elements of its hereditary bequest to the next generation — and doing so, as we saw in that earlier chapter, by participating in the winding, “mosaic”, perhaps unexpected pathway leading indirectly yet coherently from the past of its own kind to the future. But, insightful as he was in so many other regards, Lewontin did not seem to consider this possibility even to be on the table, despite his familiarity with the highly complex, coordinated, and directive aspects of individual development.

It seems that the very idea of holism is so alien to biologists that the attempt to think it is aborted before it gets very far. This is all the more odd given that some of those discouraged by the idea of holism in general are also (and with justification) enamored of the inescapably holistic idea of *phenotypic plasticity* — the individual organism’s ability to alter itself in order to adapt to a particular environment. If organisms are phenotypically plastic, then their different internal systems — for example, those involved in bone growth, muscle growth, and nerve growth — must be tightly integrated, so that they can respond adaptively and mutually to changes in each other. “Phenotypic plasticity”, we read in one enthusiastic author, “pre-adapts lineages to evolutionary change, by connecting the development of distinct organ systems”:

> Limb development requires simultaneous and co-ordinated development in other organs and tissue systems: cartilage, muscle tissue and attachment points, innervation of soft tissues; circulatory connections to tissues and bone marrow. If bone structure or muscle mass is plastic, responding to signals from the environment, co-ordinated systems must be plastic too, responding to signals from the systems developing with them … This same sensitivity of integration to the contingencies of development will make functional integration

> possible in the face of genetically-caused changes in crucial organ systems.

The author of these remarks (Sterelny 2009) happens also to be the author of the comment above about the problem holism presents for evolutionary change. It's as though, when one's attention turns to evolution, one is obligated to begin thinking of change as if it were brought about, not by the plastic and adaptive character and agency of the organism and its kind, but by random disturbances to a mere aggregate of particulate genes that somehow (in their separation and relative isolation) map to and determine the organism's phenotype.

And, yes, it is then very hard to imagine a set of scattershot changes that would, in harmony, alter the intricately interwoven, holistic way of being of an organism. But once we have acknowledged that an organism's holistic nature includes the power actively and adaptively to coordinate its physical resources, why should we so quickly forget this, especially when, in evolutionary theory, we are actually addressing the issue of holism?

I have not said anything about the degree of "quasi-independence" some organismal traits might have. I may indeed be inclined to start with the thought that organisms are far from being machines; they are not assemblages of independent, pre-fabricated parts. But if organisms consist of parts — cells and organs — that are *relative* wholes in their own right, then we would expect to see not only a principle of profound interpenetration among parts, but also manifestations of partial independence. This is worth a further look.

## Holism and the independence and integration of parts

The organism's holistic integration implies neither that further evolution is impossible nor that it is equally possible in all directions or for all species. Every type has its own future potentials, which are not the same as those of any other type. We do not look for signs that pigs will develop wings. Or, to take a different example: for all we know (and I am not proposing this) *physically* evident evolution may no longer be occurring in humans — or not occurring nearly as much as in previous evolutionary eras. It might be argued, after all, that in humans a major evolutionary transition is placing the power to direct evolution into our own hands. And this looks more like an evolution of consciousness and culture than a further bodily evolution.[8]

As for "quasi-independent" traits and holism, I think Samuel Taylor Coleridge, writing during the first half of the nineteenth century, put the question into the right perspective:

> "The living power will be most intense in that individual which, as a whole, has the greatest number of integral parts presupposed in it; when moreover, these integral parts, together with a proportional increase of their interdependence, as *parts*, have themselves most the character of wholes in the sphere occupied by them" (Coleridge 1848).

Or, re-phrased: Life will be fullest in the individual that most fully integrates the greatest number of interdependent parts; and when those parts are themselves most like independent wholes.

Perhaps we can begin to glimpse the unity underlying these apparently contrary principles when we realize how, in human society, ever stronger and more centered selves are required if we want those selves to contribute ever more strongly and selflessly to the good of the larger society. Society becomes more complex and healthier to the degree the many movements toward a strengthened independent identity and toward interdependence are mutually reinforced.

Or think of your heart or brain. These wonderfully “perfected” organs, while possessing the strongest possible identity and wholeness in their own right, are — as an expression and extension of their wholeness — bound together with everything else that goes on in the body. No part of our bodies can be separated from the circulatory and nervous systems, just as the heart and the brain cannot meaningfully function in isolation from everything else in our bodies.

In other words, the potential for holism and the potential for a (relatively) independent perfection of parts are two sides of the same coin. An overall, deeper holism depends on a greater independence and perfection of parts in their own right, and a greater independence and perfection of parts depends on a deeper holism. The two principles, despite their contrary natures, are complementary in such a way that each exists only by grace of the other. This principle of *polarity* might almost be considered definitive of the organism. For example, every organism lives by distinguishing itself from its environment — and also lives only by virtue of what it takes into itself from its environment.

Coleridge’s remark derived, I believe, from a straightforward observation of living beings and required no evolutionary theorizing. He was, of course, writing before Darwin’s *Origin*. And he was willing to look at whole organisms as they actually presented themselves. As it happens, there is nothing in evolution that contradicts this profound holism of organic life. Holism, far from making evolutionary change more difficult, is what makes whole-organism transformation, and therefore evolution, possible.

At the same time, the “hopeless” situation Lewontin imagined, where we must see the “whole organism as being adapted to the whole environment” is not so hopeless after all. Our analytical skills, whereby we mentally dissect a whole organism into its parts, are not useless, since the parts of an organism manifest a certain analyzable independence.

But what really leaves us in a hopeless position is analysis alone without a complementary movement of thought. For then we find ourselves unable to reconstitute the parts of our analysis in an integral whole. We can see only parts side by side, interacting like inanimate objects pushed and pulled by external forces. And it willl be impossible to see the organism otherwise until we come to terms with the fact that organisms have an interior dimension. (See the discussion of *idea*, *form*, *quality*, and *organize* above.)

An organism is able to act coherently as a whole because it is in fact a profoundly integral whole. But within that whole, each part is able, in its relative independence, to give its own intelligent and discriminating expression to the whole in which it participates so intimately. Yes, we have to learn to look with new eyes in order to see the integral unity of the organism. But, in Chapter 12 (“Is a Qualitative Biology Possible?”), we have at least glimpsed intimations of what that might be like.

WHERE ARE WE NOW?

## When the Organism Was Seen Whole

One paragraph from this chapter captures, I think, its most salient thought:

> Amid this diversifying whirl of cell lineages in a human embryo, where our genomes are simultaneously being summoned into the service of wildly different cellular phenotypes, we can hardly help asking: What is the unifying and coordinating source, or power, through which all the radically diverse differentiating cells are formed into coherent tissues, organs, organ systems, and the stable, functional unity of an entire human body?

During the first half of the twentieth century a considerable number of biologists, among whom E. S. Russell was a leading figure, sought to articulate a biology that kept the whole organism in view. We could, perhaps, call theirs a “common-sense view” since, as I argue throughout this book, all biologists even today reveal in their direct, observational language that they see, at least unconsciously, the truth of the agential organism — its story-telling, directive, *telos*-realizing life — in a perfectly practical sense. (See Chapter 2, “The Organism’s Story”.)

A key point emphasized here is that inheritance is never anything other than a qualitative, whole-cell inheritance; we always find ourselves watching the uninterrupted life of whole, integrally organized, living entities. It happened, however, that the seductive possibility of tracking and statistically analyzing the passage of genes from one generation to the next opened the way for the kind of logically clear, mathematized results that felt to most biologists “more like science” than did the difficult effort of acquainting themselves with the less clear-cut, qualitative character of whole cells and whole organisms.

And yet, as Russell pointed out, this narrowed the biologist’s view down to the observation of some of the genetic causal factors playing into more or less minor differences between closely allied organisms, such as parents and their offspring. (Geneticists also learned to produce monstrosities by grossly interfering with normal development, but these didn’t have a whole lot to teach us about the evolutionary potentials of viable organisms.) On top of this, geneticists blithely ignored the multicellular organism’s dramatic capacity to orchestrate the “evolution” (differentiation) of numerous cell lineages that are, in their own terms, as phenotypically distinct as distantly related species.

We have also seen here how the organism’s wholeness, or merely the thought of that wholeness, has tended to repel some biologists, who have responded with the idea that holism would make evolution impossible. Or, at least, holism is nearly impossible to work with scientifically. We heard how the argument in this direction can invoke the difficulties of holism while refusing to consider the ways in which those difficulties are overcome if we consistently keep in view the organism’s holistic character. The problems arise only when we forget what we know about that character.

In the next chapter (which can usefully be read in close conjunction with this one) I will try to pinpoint the decisive inclinations underlying the “genetic distraction” that has so powerfully wrenched the past century’s evolutionary biology away from any reckoning with the actual life of whole organisms.

## Notes

1. Figure 20.1 credit: Daderot (CC0).

2. On the relevance of Russell's work today, see "Heredity, Development and Evolution: The Unmodern Synthesis of E. S. Russell" by Maurizio Esposito (2013). For a view of Russell along with W. E. Ritter, Kurt Goldstein, Agnes Arber, and J. H. Woodger, see "A Reflection on Biological Thought: Whatever Happened to the Organism?" by Robin W. Bruce (2014).

3. Figure 20.2 credit: From Ramster 2003

4. Hybridization does in fact sometimes occur between distinctly different species (within limits, but way more often than most biologists believed not long ago) and, as I mentioned in Chapter 19 ("Development Writ Large"), this can contribute to rather dramatic evolutionary change. But such hybridization is likely to generate massive genetic and cellular reorganization, far too extensive and global to allow for conventional genetic approaches. So one is still facing the unsolved "problem of the whole" — the problem that genetic analyses were designed to steer clear of by focusing on particular genes causing particular trait differences under well-defined conditions.

5. See Lewontin 1978 and Levins and Lewontin 1985, pp. 79-80. Lewontin actually spoke of two requirements for adaptive evolution. In addition to the quasi-independence of traits and their variants, he also cited the need for *continuity*: "small changes in a characteristic must result in only small changes in ecological relations; a very slight change in fin shape [of a fish] cannot cause a dramatic change in sexual recognition or make the organism suddenly attractive to new predators" (Lewontin 1978).

6. Figure 20.3 credit: Museum of Comparative Zoology, Harvard University; copyright President and Fellows of Harvard College (CC Attribution-NonCommercial-ShareAlike).

7. On the supposed randomness of mutations, see the discussion in the concluding section of Chapter 17 ("Evolution Writ Small").

Of course, apparently random events may figure in a scientific theory. But when the whole point of the theory is to explain evolutionary change, the assignment of that change to random mutations doesn't yet give us an explanation we can reasonably call "scientific". It's basically a way of saying, "We have no scientific explanation". For the thing we want to explain isn't random at all. What we really want is an understanding of how we can characterize the origin or transformation of a trait that is present in the only way normal traits can be present — as part of the wondrous and tightly organized unity of a living being. The relation between such traits and the genes in our cells — or between such traits and the overall organization of our cells — does not look simple, and has scarcely been approached in the modern era of biology.

8. German philosopher, Dieter Wandschneider, has commented that "In a world in which sickness can effectively be cured, clinics and spas are at people's disposal, artificial limbs are applied, and replacement organs are implanted, the biological principle of survival has been 'unhinged'. And that means, too, that natural evolution has come to an end":

> One could object that the human species changes biologically even today — for example, in muscle structure, susceptibility to sickness, and life span. That cannot be denied. But these changes are manifestations of the “self-domestication” of man and thus consequences of civilization, which as such are not the results of *natural* selection. On the contrary, they are expressions of an evolution that is now taking place under completely different conditions, namely those of *cultural evolution* (Wandschneider 2005, pp. 204-5).

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