Darwin, An Introduction: Philosophical and historical aspects

Morris Soller
Department of Genetics
The Hebrew University of Jerusalem
ISRAEL

On Reading Darwin: The Origin of Species

- On reading Darwin 55 years ago:
  - Dull, dull, dull,
    - boring, boring, boring!
      - Never got to the end!
- On reading Darwin today:
  - Fascinating!
    - Each sentence poetry!
      - Laden with wisdom and balance.
        - » Couldn’t put it down!

Surprise!

- Chapter 1 of “The Origin” is all about plant and animal breeding!
  - Galapagos Islands and Darwin’s finches,
    - which we associate so closely with Darwin,
    - are relegated to a few interspersed (but very important) sentences toward the end of Chapter 12 - the next to last chapter of the book.

The object of my talk today

- To introduce you to Darwin, to his world and thought,
  - and to an understanding of the role Animal and Plant Breeding played in his thinking.
- To induce you to read, again or for the first time, if not the entire “Origins”, then at least the first chapter.
  - (www.literatureorg.com)
    - Read it slowly - allow yourself to savor every sentence, and to enjoy the company of a great mind speaking simply and directly to you

200 years back in time

- To a world that did not look at nature and biology through the spectacles of evolution.
- But that did see a world overflowing with plant and animal life, all superbly adapted to their surroundings.
- And attempted to make sense of that world - how did it come to be?

The Species Concept

- At least from the time of Aristotle and the Hebrew Bible the world of life was viewed as consisting of groups of similar or nearly identical organisms.
- These groups were termed “species”, by Aristotle; the equivalent Hebrew term in the Bible is “Min”, translated “kind”.

How did species originate?

- The accepted view within which Darwin developed as a scientist,
- The view held in common by both Aristotle and the Bible,
  - Is beautifully expressed in the opening sentences of Genesis:

Let the earth bring forth…

- The earth brought forth vegetation: seed-bearing plants of *every kind*, fruit tress of every kind… (*Genesis 1:12*)
- The waters brought forth fish in swarms, and birds according to *their kind*…(*Genesis 1:21*)
- Let the earth bring forth every kind of living creature: cattle, creeping things and wild beasts of *every kind*…(*Genesis 1: 24*)

Independent creation

- Whether ultimately attributed to G-d (The Bible) or to Nature (Aristotle), the basic view was the same:
  - Species are created *de novo* by the generative powers of the earth and its waters.
  - This is termed: “Independent creation”
    - On the theory of independent creation, the complete set of species occupying a region was the “Production” of that region in the most literal sense.

Not a matter of religious belief

- Aristotle obviously did not have Deity in mind when he proposed independent creation as the explanation for the existence of species.

Not so foolish

- In the 18th Century, alchemistry still reigned.
- In this view the basic elements are earth, water, air and fire, and each strives to transmute into the higher element -
  - so that in principle, under special circumstances - lead can be transmuted into gold.
- From an alchemical view, it was quite reasonable to imagine that under special circumstances, earth and water, fire and air can transmute into a living creature.

Support for independent creation: (1) Adaptation

- The species of each region are precisely adapted to the geoclimate of the region.
  - The “productions” of the artic are precisely suitable to a cold climate,
  - The “productions” of the tropics are precisely suitable to a warm-humid climate.
- This is just what would be expected on the theory of independent creation -

(2) Same species – Widely separated locations

- The same “Alpine” plant species are found on widely separated mountain peaks -
  - On the European Alps, and on the mountain peaks of Tierra del Fuego, at the tip of South America.
- Widely separated rivers and lakes across a continent share the same fish and plant species,
  - although there are no physical connections between them -
  - and fish and water plants do not fly or traverse large open spaces.

- The same terrestrial species are found on Volcanic islands and on the mainland, though separated by hundreds of km of open sea.
  - The Galapagos Islands share many species with Ecuador, 972 km away!
- The most obvious explanation of these and similar examples is that each species was created independently again and again, according to what is most suitable for the particular region.

(3) The fossil record – Sudden appearance of new species

- When the fossil record is examined:
  - a species and often a group of related species appears suddenly in the record,
- The sudden appearance of a species in the fossil record obviously accords well the notion that species are created *de novo* at a particular time,
  - Indeed it is for this reason that paleontologists such as Cuvier and Asa Gray were the most adamant scientific opponents of evolution.

Problems for Independent creation: (1) Similar climate, different species

- On the theory of independent creation, we expect widely separated regions with the same geography and climate to share the same species,
  - This is far from being the case -
    - Generally, widely separated regions with very similar geography and climates - have fundamentally different “Productions”.

Examples

- A multitude of European plants and animals have naturalized in South America and Australia.
    - Showing that conditions are quite similar
  - Yet, there is not a single native mammal common to Europe, Australia or South America.

- The oceans to the East and West sides of the Isthmus of Panama are separated by only a few miles, and share exactly the same climatic conditions.
  - Yet, their flora and fauna are completely distinct.

(2) Species generally limited to single region

- Species are generally limited in geographic distribution to a single defined region, or to separated regions with physical connection between them.

Single centers of creation

- A species is created *de novo* in a single region only, and spreads from there by physical dispersal.
- Thus, different regions, even when sharing the same geoclimate, will have their own productions,
  - These productions, while adapted to the region, will each have its own special nature.

The strange case of the missing frogs

- “Batrachians (frogs,toads, newts) have never been found on any of the many islands with which the great oceans are studded.
  - Why on the theory of creation, they should not have been created there, it would be very difficult to explain.”

…….And of the omnipresent bats

- “Mammals offer another and similar case - there is not a single instance of a terrestrial mammal inhabiting an island situated above 300 miles from a continent.
- Though terrestrial mammals are absent – bats are found on almost every island
  - Why has the creative force produced bats and no other mammals on remote islands?”

Affinity of Oceanic Islands to the nearest mainland

- "The most striking and important fact for us in regard to the inhabitants of islands, is their affinity to those of the nearest mainland, without being actually the same species."
  - "Numerous instances could be given of this fact. I will give only one, that of the Galapagos Archipelago….

- “There are twenty-six land birds, and twenty-five of those are ranked by Mr Gould as distinct species, supposed to have been created there;
  - yet the close affinity of most of these birds to (South) American species in every character, in their habits, gestures, and tones of voice, was manifest.
- So it is with the other animals, and with nearly all the plants…”

- Why should this be so? why should the species which are supposed to have been created in the Galapagos Archipelago, and nowhere else, bear so plain a stamp of affinity to those created in America?
  - There is nothing
    - in the conditions of life,
    - in the geological nature of the islands,
    - in their height or climate,

  which resembles closely the conditions of the South American coast:
  - in fact there is a considerable dissimilarity in all these respects.

- On the other hand, there is a considerable degree of resemblance in the volcanic nature of the soil, in climate, height, and size of the islands,
  - between the Galapagos and Cape de Verde Archipelagos:
- but what an entire and absolute difference in their inhabitants!

The final break with creationism

- "The inhabitants of the Cape de Verde Islands are related to those of Africa,
  - like those of the Galapagos to America.

- *I believe this grand fact can receive no sort of explanation on the ordinary view of independent creation"*

Descent with modification

- New species are created through modification of existing species:
- Explains all of the above aspects of species distribution in space and time. In particular,
  - *"…the Galapagos Islands would be likely to receive colonists… from America; and the Cape de Verde Islands from Africa; …. such colonists would be liable to modifications; the principle of inheritance still betraying their original birthplace".*

Lamarck (1744-1829)

- Three part complete theory of evolution based on Descent with Modification (1802)
  - Simple species are continually created *de novo*
  - A “complexifying” force, analogous to the “transmutation” force of the alchemist, drive the simple species up the complexity ladder of life: sponges, echinoderms, insects,vertebrates, mammals, man.
  - Use and disuse modifies heredity and adapts the products of the complexifying force to their biogeographic surroundings.

Darwin

- Darwin embraced the idea of “Descent with Modification”,
- But by Darwin’s time,
    - Alchemical thinking completely discredited,
- Consequently, Darwin could not accept Lamarck’s Complexifying force.
  – But use and disuse alone, insufficient to generate the full scale of life.

The challenge

- What is the force in nature leading to "descent with modification?"
- Note also
  - Modification alone is not sufficient,
  - The responsible force must lead to *adaptive* modification

What does a scientist do?

- What does a scientist do when faced with a challenge to explain something for which there is no accepted explanation?
- He shows that it corresponds to something that he can explain,
- And uses that explanation for the new problem.

Newton and the apple

- How to explain the moon revolving about the earth - this contradicted his laws of motion.
  - He saw the apple fall
  - He had an explanation for this
- If the moon is like the apple, then the same force that causes the apple to fall toward the earth will keep the moon from flying away from the earth.

Three insights

- To achieve this, Darwin combined three insights - all three essential for the final theory to work.
  - (like a complex organ such as the eye, where all parts need to function for the eye as a whole to function)

Observations leading up to Darwin's first insight

- All species exist as local populations.
- These can differ among themselves in morphology.
- If two local groups differed sufficiently they were declared different species;
  - If they differed less than some critical amount, they were termed “varieties” of the same species.

- The action on the individual of local geoclimate was considered the force generating varieties from species.
  - Thus, all agreed that varieties were descended by modification from existing species -
  - they were not created *de novo*.

Varieties grade into species

- There is a gradation in the degree of difference between local groups,
  - From that which all would consider “varieties:
  - To that, which all would consider “species”,
  - And all states in-between.

Graded series = transitional forms

- Whenever we observe a graded series, with many intermediate and transitional forms,
  - A plausible interpretation is one form developing into the other.
    - Baby to child to teenager to adult
    - Prophase to metaphase to anaphase to telophase

Varieties as steps to species

- Similarly, in his first great insight, Darwin interpreted the graded differences among varieties and spieces,
  - as indicating that varieties gradually come to differ more and more from their parent species,
    - and eventually transform into independent species.
    - *"…I look at varieties… as steps leading to sub-species and to species…"*

The search for the cause of differentiation among varieties

- ”The passage from one stage of difference to another and higher stage
  - may be, in some cases,
  - due merely to the long-continued action of different physical conditions
  - in the two different regions;
- but I have not much faith in this view”

Observations leading to Darwin's second great insight!

- All domesticated plants and animals present a wide spectrum of varieties (plants) and breeds (animals).
- How did these originate?

Darwin's pigeons

- "…Altogether at least a score (20) of pigeons might be chosen,
  - which if shown to an ornithologist,
    - and he were told that they were wild birds
- would certainly, I think, be ranked by him as well-defined species... "

- Yet all must be descended from rock pigeons (Columba livia) -
  - that is, (from species) not breeding or willingly perching on trees.
- But besides C. livia, only two or three other species of rock-pigeons are known;
  - and these have not any of the characters of the domestic breeds.”

Breeds correspond to varieties

- Thus, breeds in domestic species, must originate by modification from the same parent species;
- Thus, they correspond to varieties in natural species.
- *The question now becomes - what is the force that causes breeds to develop in domestic species!*

Adaptation

- “…One of the most remarkable features in our domesticated races is that we see in them adaptation, not indeed to the animal's or plant's own good, but to man's use or fancy…”

- ‘When we compare –
  - The dray-horse and race-horse,
  - The various breeds of sheep fitted either for cultivated land or mountain pasture,
    - with the wool of one breed good for one purpose,
    - and that of another breed for another purpose;
- When we compare –
  - The many breeds of dogs,
    - each good for man in very different ways;

- When we compare –
  - The gamecock, so pertinacious in battle,
    - with other breeds so little quarrelsome,
    - with 'everlasting layers' which never desire to sit,
      - and with the bantam so small and elegant; …”

Darwin's second great insight: Selection

- "…We cannot suppose that all the breeds were suddenly produced as perfect and as useful as we now see them;
  - indeed, in several cases, we know that this has not been their history.

The English livestock breeders

- The great English breeder Robert Blakewell who died only five years before Darwin's birth, had formed the famed Leicester breeds of cattle and sheep.
- The Colling brothers developed the English Shorthorn while Darwin was growing up.

The cumulative effect of recurrent selection

- The key is man's power of accumulative selection:
  - nature gives successive variations;
    - man adds them up in certain directions useful to him.
- What is it, in nature that corresponds to the selection of the breeder?

Darwin's Third great insight: Survival of the fittest -Natural selection

- "In October 1838, that is, fifteen months after I had begun my systematic inquiry,
  - I happened to read for amusement Malthus on Population,
- and being well prepared
  - from long- continued observation of the habits of animals and plants,
  - to appreciate the struggle for existence which everywhere goes on

The final brick in place

- it at once struck me that under these circumstances (of struggle for existence) favourable variations would tend to be preserved, and unfavourable ones to be destroyed.
- The results of this would be the formation of a new species.
- ***Here, then I had at last got a theory by which to work".***

  (Charles Darwin, from his autobiography, 1876)

Charles Darwin: 1809-1882

- The 19th Century opened to a still magical world
  - Where earth, water, fire and air transmuted into tulips and butterflies.
- The 19th Century closed to a more prosaic world
  - where tulips and butterflies formed by reproductive over-potential, competition for survival and mates, and natural selection

Gerald Manley Hopkins (1844-1889)
God's Grandeur

- The world is charged with the grandeur of God
  - It will flame out, like shining from shook foil……
- ….All is seared with trade, bleared, smeared with toil,
  - The soil is bare now, nor can foot feel, being shod….

Darwin - (The origin of species)

- “There is grandeur in this view of life, with its several powers,
  - having been originally breathed into a few forms or into one;
- and that, whilst this planet has gone cycling on according to the fixed law of gravity,
  - from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved”

Psalm 92:5

- For Thou, Lord, has made me rejoice in your deeds,
  - I sing of the products of your hands!
- How great are Thy works, O Lord,
  - your thoughts are very deep!

Thank you!