Physics and *Generation and Corruption*

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Knowledge of Nature

- If the subject of a line of inquiry has principles, causes, or elements, we have scientific knowledge by knowing them
- The first task of a science of nature (*physis*) is to know the principles of nature
- As with all knowledge, we advance to what is known best by nature from what is known best to us
- We best know inarticulate wholes

Coming to Be

- In every case of coming to be, there is a subject that comes to be
- Substances come to be without qualification
  - Socrates begins to exist
- Properties of substances come to be in a way qualified by the substance
  - An unmusical man comes to be a musical man

Origins

- In qualified coming to be, properties are replaced by their opposites
- In unqualified coming to be, a new subject comes to be from an existing subject or subjects
  - Living things from seed
  - Statues from change of figure in the stone
  - Houses from composition of building materials

Modes of Change

- There are several ways in which a subject changes while continuing to exist
  - Growth or decay: a change between contrary quantities
  - Locomotion: a change between contrary places
  - Alteration: a change in attributes
- A subject comes to be after it did not exist before, and it perishes when it ceases to exist

Principles of Coming to Be

- On one way of counting, there are two principles of qualified coming to be
  - The subject (Socrates)
  - Contraries (musical, unmusical)
- On another way of counting, there are three
  - The subject (Socrates)
  - A property (musical)
  - A privation of that property (unmusical)

Coming to Be from What is Not

- Earlier philosophers such as Parmenides suffered from inexperience
- They held that there is no change because nothing can come to be from what is not
- This is true in the unqualified sense, but false in a qualified sense
- Something can come to be from something insofar as it is not *that something*
  - A substance comes to be from a substance
  - A substance comes to be of a kind that it was not when a property comes to be from its privation

Natural Things and Artifacts

- We say that some existing things are natural
  - Animals, plants, and their parts
  - The simple bodies
    - Earth
    - Fire
    - Air
    - Water
- Other existing things are artificial
  - A bed
  - A cloak

The Difference between Natural Things and Artifacts

- Natural things have within themselves a principle of motion and stability
  - In place, or
  - In growth and decay, or
  - In alteration
- Artificial things are the product of craft
- They have no innate impulse to change, except to the extent that the materials that make them up have such an impluse

Nature

- The principle of change and stability in natural things is their nature
- Things that have a nature are substances
  - Natures are always in a subject
  - A substance is a sort of subject
- What is in accordance with nature are
  - Natural things
  - What belongs to natural things in their own right
    - Traveling upward belongs to fire

Does Nature Exist?

- It is evident that there are natures and natural things
- Any proof of their existence would require premises that are not evident
- One cannot prove what is evident from what is not evident
- Any attempt to do so is the result of not being able to distinguish the evident from the not-evident

Nature as Matter

- In one sense, the nature of a thing is the material from which it is composed
  - The nature of a bed is the wood
  - The nature of a statue is the bronze
- The reason is that the material remains the same (e.g., as wood) even when transformed by someone working on it
  - If a buried bed were to sprout, that would show that its nature was wood all along (Antiphon)

Nature as Material Element

- Some people take elements to be the nature of things because they have no principle of change in them and persist everlastingly
  - Earth
  - Fire
  - Air
  - Water
- The element is the only substance there is
  - All else is attribute, condition, or state of the elemental substance

Contraries

- The fundamental qualities of bodies are those which are perceived by touch
  - Not paleness/darkness
  - Not sweetness/bitterness
- There are many tangible contraries, but only two pairs of them are active
  - Hot/cold
  - Wet/dry
  - Not heavy/light, hard/soft, etc.

The Elements

- Each of the elements embodies one from each of the pairs of active, tangible qualities
  - Fire: hot and dry
  - Air: hot and wet
  - Water: cold and wet
  - Earth: cold and dry
- There is more than one element, because elements change into one another
  - Fire is not hot air, because air is by nature wet, while fire by nature is dry
  - Fire becomes air by exchanging dry for wet

Nature as Form

- In one sense, the nature of a thing is the form or shape in accordance with the account of the natural thing
  - Bone is a natural thing whose account is the way it exists as bone
- The form is not separable from the thing
- When a something is potentially a natural thing, it lacks the form makes it an actual natural thing
  - Earth is potentially bone

Teleology

- The form is more the nature than is the matter
  - The form is always actual, while the matter may be only potentially a natural thing
- What is most fully the nature of a thing is the end (*telos*) toward which change moves
- “What is it, then, that grows? Not what it is growing from, but what it is growing into” (*Physics*, Book II, Chapter 1)

Natural and Mathematical Science

- Natural bodies have coincidents that are studied in mathematics
  - Surfaces
  - Lengths
- The geometer studies surfaces, lengths, etc. in their own right, not as limits of bodies
- Some mathematical sciences study the coincidents as properties of bodies
  - Astronomy
  - Optics

Nature and Craft

- Craft imitates the natural process of change
- The house builder must know
  - Building materials (what is for the end)
  - The form of the house (the end)
- So too the student of nature must know both the matter and the form of natural things
- The important thing to know about the matter is what it is for, the form
  - The doctor needs to know what bone is for

Causes

- Our interest is knowledge of nature, which includes coming-to-be and perishing, and other natural changes
- We have knowledge of these things only when we find the primary causes or reasons that they take place
- If we know in general the causes of change, we can apply our knowledge to specific cases of change
- The genus of a cause is also a cause

Four Kinds of Cause

- There are four kinds of causes of change
  - The material from which something comes to be (material cause)
    - Bronze, silver, and metal are causes of a bowl
  - The form or pattern which is an account of the essence of a thing (formal cause)
    - The ratio 2:1 and number are causes of an octave
  - The source of change or stability (efficient cause)
    - The father is the cause of a child
  - The end for which something exists (final cause)
    - Health is the cause of walking

Material Cause

- The material cause is a component of “things that come to be”
- There are several ways in which something can be a component of another
  - As proper parts
    - Letters/syllable
  - As the material of which a thing is made
    - Earth/bodies
  - As that from which something else comes to be
    - Assumptions/conclusions

Formal Cause

- The formal cause or essence is the cause of “unmoved things”
- In the example of an octave, a certain musical sound is the result of pushing down the string of the lyre at its mid-point
  - The essence of that sound is the form, a 2:1 ratio
- The “whole” and the “composition” can also be the essence of the parts
  - Bronze makes up a statue insofar as the whole has a certain shape

Efficient Cause

- The efficient cause is the source of what makes a thing change or remain the same
- It is the producer which brings about change
  - The seed produces an animal or a plant
  - The doctor produces health in a patient
  - A raid by the other side produces a war
- The efficient cause need not be an individual agent, but may be that through which the agent brings about change
  - The art of sculpture produces the sculpture

Final Cause

- The final cause is the end for which change takes place
- The end may be understood as the good
  - A person walks for health, which is the good which comes from walking
- The good may be real or apparent
- Final causes need not be what is consciously intended
  - A tree may shed its leaves in the winter to survive the cold weather

Proper and Coincident Causes

- The proper cause of a thing is that in virtue of which the thing is the kind of thing it is
- A coincident ("accidental") cause is what accompanies a proper cause but does not contribute to making the effect what it is
  - A sculptor is a proper cause of a statue
  - Being Polycleitus is coincident to being a sculptor
- We may speak of the proper and coincident causes either together or separately

Luck and Chance

- We say that luck and chance are causes of many things that are or come to be
- Yet a case can be made that nothing occurs as the result of luck
  - A definite cause can be assigned to everything that is or comes to be
- We need to explain the fact that people believe two apparently opposing things
  - Everything has a cause which is not luck
  - Luck is nonetheless a cause

Beliefs of the Wise About Luck

- Philosophers before Aristotle did not assign luck a role in their accounts of the primary causes in the universe
  - Empedocles: love and strife
  - Heraclitus: fire
- Yet they did assign a specific role to luck
  - Empedocles: the parts of animals are due to luck
  - “Other people”: the general configuration of the heavens and the most divine visible things is the result of luck

Analysis of Luck

- We do not attribute to luck things which occur always or most of the time
- Nor do we attribute to luck things which occur for some end
- Lucky events are unusual outcomes that do not come about for an end
- Luck is a cause that is coincident to things that occur for another end
  - I rarely go to a bar, but one time I go to have a drink and meet someone who owes me money

Some Features of Luck

- Luck is never the primary cause of anything
- An indefinite number of coincidental (lucky) causes may bring about the same event
  - I go to the bar to meet someone, to apply for a job, to watch a football game on the wide screen
- Luck is contrary to reason
  - It is not the usual cause, and so it would be irrational to expect it to be a coincidental cause
- Good luck and bad luck are so-called because of their results

Chance

- Chance extends more widely than luck
  - Luck applies only in cases where something can be fortunate or unfortunate as the result of action
- What is incapable of decision cannot do anything by luck
  - Inanimate things
  - Non-rational animals
  - Children
- Chance can apply to them
  - The horse came to find water by chance

Analysis of Chance

- Where there is an end for mind or nature, a chance cause is one which brings about the end in a coincidental way
- What occurs by chance is pointless
  - When something is done in a way that does not properly promote an end, it is said to be pointless
    - The stone fell pointlessly by chance, even though it could have fallen because thrown to hit someone
- What is contrary to nature is most clearly chance, apparently since no end is involved

Necessity

- We can understand all changes in nature to have come about through necessity
- This seems to leave no place for final causes
  - It rains because of the behavior of wet and cold things, rather than to help the crops grow
- Bringing about the end seems to be coincidental in the case of non-living things
- Empedocles held that living things came to have their specialized organs without an end

The Need for Final Causes

- Specialized organs in living things cannot have come to be by coincidental causes because they come to be always or usually
- If they do not come to be by coincidental causes, then they come to be for something
- Craft imitates nature, and given that the products of craft are for something, so are the products of nature

The Teleology of Nature

- It is common to believe that ends exist only where there is rational deliberation
- But irrational beings behave purposefully
  - Spiders make webs
  - Plants produce leaves that protect their fruit
- Crafts are productive as well, though they do not deliberate
- Nature is like a doctor applying medical treatment to himself

Necessity in Natural Things

- Necessity in material causes explains why things maintain their current configuration, but not how they came to be that way
  - The heaviness of the stones explains why the wall they support stands, but not why the wall exists
- Mathematical necessity also explains features of natural objects
- The form contributes an element of necessity, as it determines the materials needed for the form to be realized

The First Cause

- A thing may move as a result of a series of causes
  - The agency of a man causes the agency of his hand, which causes the stick to move, which causes a stone to move
- The first cause is the primary cause
  - The other causes, and the final motion, exist because of it
- Because an infinite series of causes is impossible, every motion has a first cause

The Unmoved Mover

- A first cause is not moved by anything else
- So, in every motion, there is a mover which is not itself moved, but moves by its own agency
- Motion never ceases
- Therefore, there is one or more everlasting first movers
- We should assume that there is only one, since this is sufficient for explanation and the simpler the explanation, the better