JOHN PAUL THE GREAT CATHOLIC UNIVERSITY

PHILOSOPHY OF NATURE
Course Reader

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Table of Contents

From *The Mesopotamian School and Theodore of Mopsuestia*

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Mesopotamian Cosmology – Enuma Elish

The precise nature of the Babylonian "Epic of Creation" is not, strictly speaking, that of a book of cosmology. It is more accurately described as a story about Marduk and his ascent to the head of the Babylonian pantheon, wherein the creation of the world is described as a sub-story.[1] Still, the creation story within the *Enuma elish* is "the principal source of our knowledge of Mesopotamian cosmology."[2] Nor are we in any sense "forced" to rely on the Epic merely because there has been little else discovered by way of "creation stories" in Mesopotamia – though the creation account makes up only a small portion of the *Enuma elish*, it is still, according to Jacobsen, "a very remarkable attempt at coming to terms with, at understanding, and at accepting the universe."[3]

The Creation Epic, as it is often called, was written sometime between 1200 and 1600 B.C.[4] It was used, most likely, as the text of a kind of liturgical service on the New Year Festival on

[1] See Alexander Heidel, *The Babylonian Genesis* (Chicago: Phoenix Books, 1951), 10-11: "*Enuma elish* is not primarily a creation story at all. If we were to put together all the lines which treat of creation, including the theogony and even granting that most of the missing portion of Tablet V deals with works of creation, they would cover not even two of the seven tablets but only about as much space as is devoted to Marduk's fifty names in Tablets VI and VII….*Enuma elish* is first and foremost a literary monument in honor of Marduk as the champion of the gods and the creator of heaven and earth…the story of the creation of the universe, was added not so much for the sake of giving and account of how all things came into being, but chiefly because it further served to enhance the glory of Marduk and helped to justify his claim to sovereignty over all things visible and invisible."

[2] Ibid., 10.

[3] Jacobsen, 167. See also N. K. Sandars, *Poems of Heaven and Hell from Ancient Mesopotamia* (New York: Penguin Books, 1971), 11: "[*Enuma elish*] is about the foundation of the world and of the foundation of Babylon, the great city, the world's center."

[4] Bottero affirms the former (242) and Stephanie Dalley the latter in *Myths from Mesopotamia* (New York: Oxford University Press, 1989), 229.

what is now April 4th.[5] It is not, however, so much the practical use of the poem as its underlying teachings about the universe that concern us here. Assuming that this piece of literature, like the Gilgamesh Epic and any piece of literature, reflects the attitudes and genius of its time and place, what can we learn about the Mesopotamian mind from this work? I would ask three questions, and in turn produce three answers, regarding this text: first, *what is it in the cosmos which is conspicuous enough to require divine explanation?* Second, *in what terms is the material element of the physical world explained?* Finally, *how was the world as we now know it actually brought into being, and what does this tell us about how we humans should approach it?*

The creation of the world takes place in Tablet V of the Epic, and occurs after a great battle whereby Marduk, a young but powerful god, defeats and kills Tiamat, the second "oldest"[6] of the gods after Apsu and mother of all, who had existed eternally, as we learn from the first lines of the Epic:

> When the skies above were not yet named
> Nor earth below pronounced by name,
> Apsu, the first one, their begetter
> And maker Tiamat, who bore them all…
> Had mixed their waters together,
> But had not formed pastures, nor discovered reed-beds;
> When yet no gods were manifest,
> Nor names pronounced, nor destinies decreed,
> Then gods were born within them.[7]

After the youngest gods are engendered, and prove themselves too rowdy for their parents, Apsu angrily attempts to silence them and is killed by Ea. Ea then sets up his abode atop of Apsu (the Akkadian

[5] See Sandars, 39: "So much is known about the New Year spring festival at Babylon that we can go a long way towards reconstructing the actual scene when, on the evening of the fourth day of the month Nisan (April), the priest of Marduk stood in an inner room alone in front of the figure of the god, to chant the entire creation poem."

[6] It is not clear whether Tiamat and Apsu *had* a beginning, or even whether temporality can be applied at all to any of the events in the Epic. This will be discussed in greater detail later.

[7] Dalley, 233.

word for "abyss"), and he and his lover Damkina give birth to the greatest of the gods, Marduk.[8] During this battle, Tiamat had played the part of a good mother, attempting to appease Apsu's wrath. After her husband is killed, however, and the young Marduk awakes her and the older gods once again with his exuberance, she is more easily angered and moved to battle. The next few tablets describe the preparations for battle on both sides and the battle itself, but what concerns us here is that, after his victory, Marduk uses the body of Tiamat to create an abode for himself and the other gods. This is the context of the creation story in *Enuma elish*.

It is here that we may ask our first question: *what is it in the cosmos which is conspicuous enough to require divine explanation?* This is a relevant question – even *the* relevant question because there are so many possible answers that the ones chosen by the author of *Enuma elish* reflect immediately what his mind was concentrating on, what it found interesting and noteworthy – even surprising and wondrous - about the world. "[Marduk] divided the monstrous shape and created *marvels*…"[9] What, then, were these marvels that Marduk created? Tablet V begins:

He fashioned stands for the great gods.
As for the **stars**, he set up **constellations**
corresponding to them.
He designated the **year** and marked out its divisions,
Apportioned three stars each to the **twelve months**.
When he had made plans of the days of the year,
He founded the stand of Neberu to mark out their courses,
So that **none of them could go wrong** or stray…
With [Tiamat's] liver he located the Zenith;
He made the crescent **moon** appear, entrusted night (to it)
And designated it the jewel of night to mark out the days.
'Go forth **every month without fail** in a corona,

[8] Ibid., 235: "[Ea] held Apsu down and slew him…He set his dwelling on top of Apsu…And inside Apsu, Marduk was created; Inside pure Apsu, Marduk was born."

[9] Ibid., 255.

At the beginning of the month,
to glow over the land.
You shine with horns to mark out six days;
On the seventh day the crown is half…
The spittle of Tiamat Marduk put into groups
and made **clouds** scud.
Raising **winds**, making **rain**,
Making **fog** billow, by collecting her poison,
He assigned for himself and let his own hand control it.
He placed her head, heaped up [ ]
Opened up **springs**: water gushed out.
He opened the **Euphrates** and the **Tigris** from her eyes…
He piled up clear-cut **mountains** from her udder,
Bored waterholes to drain off the catchwater…
He set her thigh to make fast the **sky**,
With half of her he made a roof; he fixed the **earth**…[10]

The phenomena which are explained in this creation story fall into two categories: temporal cycles and objects in nature. In the first category we find the arrangement of years and months, the cycles of the sun and moon. In the second category we find cloud, wind, rain, springs, the great rivers, mountains, and the heavens and the earth themselves.

Regarding the explanation of temporal cycles, we may ask specifically what it was that was interesting enough about, for example, the waxing and waning of the moon that required a divine explanation? The answer is given in two separate lines: "…so that none of them could go wrong…" and "…every month without fail." It is precisely the *reliability* of the lunar and solar cycles that are conspicuous enough to the Mesopotamian to require a mythological explanation. Similarly with physical phenomena, it is *the very fact of their existence* that seems to demand an explanation. Nor is this an insignificant or redundant point: of all the possible aspects of reality interesting enough to draw the attention of the Mesopotamian, darkness, destruction, death, silence, emptiness, pain, etc., it is specifically the *positive* aspects that actually draw it. It is as if the total contingency of the universe

[10] Ibid., 255-257, selected verses. Emphasis mine.

is recognized, and nothing, not even existence itself, is taken for granted.[11] For the Mesopotamian, then, the basic attitude toward physical reality is one of positive acceptance, *wonder* or even *gratitude*.

In asking our second question, in what terms the physical constitution of the cosmos is explained in the Mesopotamian tradition, we look to the same passage quoted above, only through a different lens. The wondrous things in nature are only half explained by the creative activity of Marduk; he is their creator, but he did not create *ex nihilo*: their primal source – the ultimate material cause of the universe – is the body of the defeated goddess Tiamat. Here there is a marked contrast between the early Mesopotamian and much of the later ancient world's attitude toward physical reality: where the Manichean or Plotinian would have described matter as low or even evil, the Mesopotamian, gazing upon the physical universe with wonder, has no recourse but to assign *to matter itself* a divine "material."

This being the case, it is noteworthy that the Mesopotamian therefore would not have seen matter – or its divine source Tiamat – to have ever had a "beginning" of any kind: the opening lines of the Epic quoted above testify to that. N. K. Sandars explains this in the introduction to her translation of the Epic:

> At the end of the poem all three primordial existences, Tiamat-Apsu-Mummu, have been defeated; they are 'dead' or, like Mummu, locked away. But for the Babylonians the material world was eternal; nothing is ever wasted in this thrifty universe, not even death. We know this also from Diodorus Siclulus, the Greek geographer who was born in the first century B.C. 'The Chaldeans say that the substance of the world is eternal, and that

[11] See Dalley's Introduction to her translation of the Epic, 228: "The forces of evil and chaos are overcome, whereupon the present order of the universe can be established, with its religious centres, its divisions of time, its celestial bodies moving according to proper rules, and with mankind invented to serve the gods. The gods themselves behave in an orderly fashion."

> it neither has a first beginning nor…will at a later time suffer destruction.[12]

To see the physical world as eternal is to see it with drastically different eyes from those of any modern American trained and taught by popular science to think of the "beginning" of the world as the Big Bang. Indeed, this fundamental difference in cosmological doctrine seems to reflect a – or even *the* – fundamental difference in philosophical perspective in one's approach to the world.[13]

There also seems to be a connection between anthropology and cosmology in the Epic. The creation of human beings occurs in much the same way as that of the rest of the cosmos; out of a particular need of the gods, Marduk uses parts from a deceased god to create. In the case of the cosmos, the gods wanted a place to live, and so Marduk used Tiamat's body as material for the world. In the case of human beings, the gods wanted servants to work for them and allow them to live a life of

[12] Sandars, 28. She goes further on 61: "In the Babylonian poem there is, strictly speaking, no creation at all. Matter is eternal, Tiamat and Apsu provide, from within themselves, the material of the whole universe."

[13] Sandars concludes her introduction (70): "We can choose today between Continuous Creation and the Big Bang, and the ancient world had the same choice. Creation of the universe *ex nihilo* by Yahweh was a cataclysmic physical event as much as any Big Bang, or series of bangs which may still be whispering round the universe; while the cyclical turnings of time, and the eternal uncreated matter of the Babylonian cosmography, perpetually evolving into greater complexity yet liable to regress into a simpler state, has its counterpart in Continuous Creation. Whatever the nature of the difference, whether theological of physical, it surely represents at bottom a difference of psychological, or mental, tone. We do not know the reason but it is very probably that the antinomy was there from the first beginning of man's thoughts about beginnings." I would like to return to this theme periodically throughout this thesis: that what I call the Mesopotamian School represents or even is merely a representation one of the two primordial and fundamental approaches to the world by the human mind. This will become most evident in the later discussion on Alexandria as the cultural center which later embodies the *other* primordial approach. It will be useful then to describe the two in parallel in order especially to give our School more precise definition by contrast, but for the sake of space the Egyptians must be constricted to one section only.

leisure, and Marduk uses the blood of Kingu, the head of Tiamat's army of gods, to create humanity:

'Let me put blood together, and make bones too.
Let me set up primeval man: Man shall be his name.
Let me create primeval man.
The work of the gods shall be imposed on him,
And so they shall be at leisure.'[14]

The refinement of the anthropology of the Epic is impressive: though human beings are made from the blood of a god, they are mere servants; though they are mere servants, the work they do is the very work of the gods. The case is the same, though slightly more complex, in the *Ahra-hasis* epic, where Enlil and Mami make humanity, for the same purpose as that described in *Enuma elish*, out of a mixture of a dead god's blood, clay and divine spittle.[15] We will find this motif, that human beings are *by nature* a mixture of greatness with lowliness, throughout Mesopotamian thought, finding its highest expression in Narsai. But the insight here is this: that there seems to be a connection, even a causality, between a basic, heartfelt acceptance of the precariousness of the human condition and an attitude of wonder and gratefulness toward the word. Realism and humility, in other words, lead to wonderment and joy in everyday life.[16]

Not only is the physical universe gazed upon with wonder as made from the body of the oldest goddess, it is also the abode of many of the gods themselves:

Then Marduk the king divided the gods,
The Anunnaki, all of them, above and below.

[14] Dalley, 260-261.

[15] W. G. Lambert, "Myth and Ritual as Conceived by the Babylonians," *Journal of Semitic Studies* 13:1 (1968): 104.

[16] The sentiment is expressed beautifully by Chesterton: "The whole point depends upon [man's] being at once humble enough to wonder and haughty enough to defy…We must have in us enough reverence for all things outside us to make us tread fearfully on the grass. We must also have enough disdain for all things outside us, to make us, on due occasion, spit at the stars…Man must have just enough faith in himself to have adventures, and just enough doubt of himself to enjoy them." *Orthodoxy* (San Francisco: Ignatius Press, 1986), 318.

He assigned his decrees to Anu to guard,
Established three hundred as a guard in the sky;
Did the same again when he designed
the conventions of earth,
And made the six hundred dwell
in both heaven and earth.[17]

Many of the gods, three hundred to be exact, live on earth. Even "heaven" here may – and most probably does – refer to the physical sky rather than a spiritual abode. For the Mesopotamian, there is no separation, or even distinction, then, between the world of the gods and our physical world here on earth. Babylon itself was built, according to our Epic, to be an abode for the gods. Jacobsen summarizes: "Marduk's first demand upon the gods was that they build him a city and a house to serve as a permanent royal administrative center and a place for them to stay when they gathered for an assembly: a signpost to permanence. Its name was to be Babylon…They suggested that they themselves move to Babylon."[18] Marduk grants the request of the Anunnaki, the builders of Babylon: "'Indeed, Bab-ili[19] is your home too! / Sing for joy there, dwell in happiness!' / The great gods sat down there, / and set out the beer mugs; they attended the banquet."[20]

This basic identity between the world of the gods and the world of human beings has given scholars certain insight into the practical use for the Epic of Creation in liturgical service as well as a possible theory as to the inspiration of the creation story itself. As for the first, Sandars describes the liturgy in which the Epic was read as not only a re-creation but even a repetition of the legendary events narrated thereby: "Continual mental and ritual activity were needed simply to hold the world in equilibrium. Marduk's battle must be fought year after year. Tiamat is never entirely conquered…" She continues: "Earth mirrors heaven, and the earthly liturgy echoes the heavenly. *Ubshukinna*, the Chamber of Destiny, timeless, divine, is also a room of Marduk's brick palace

[17] Dalley, 262.

[18] Jacobsen, 180.

[19] "Bab" is Akkadian for "gate and "ili" the genitive of "ilu," "gods," and therefore "Bab-ili" means "gate of the gods."

[20] Dalley, 263.

beside the Euphrates; a mound of earth in which you can dirty your shoes today. The great *ziggurat* of Babylon was called the *Etemenanki*, the 'House of the Foundation of Heaven and Earth,' the common term for the whole universe, which indeed it was…"[21] Concurrently, Jacobsen describes the physical phenomenon which may have inspired our author's explanation of the creation of the world:

> The speculations by which the ancient Mesopotamian sought to penetrate the mystery of origins were based, apparently, on observations of how new land came into being. Mesopotamia is alluvial, formed by silt brought down by the rivers. It is the situation at the mouth of the rivers where the sweet waters, Apsu, flow into the salt waters of the sea, Tiamat, and deposit their load of silt, Lahmu and Lahamu, to form new land that has been projected backward into the beginnings.[22]

If this theory is true, it gives us another insight into the Mesopotamian psyche: the physical world and its observable activities today are important enough to tell us even about the creation of the world by the activities of the gods ages ago. Indeed, there is nothing in the documents we have today to suggest that the question "where were the gods when they created the world?" was ever even asked. This should suffice to show that there was, for the Mesopotamian mind, only one world, a physical one, in which both the gods and human beings dwelt.

Our third question was *how was the world as we now know it actually brought into being, and what does this tell us about how we humans should approach it?* We have discussed already how the physical world was brought into being from the body of Tiamat and through the agency of Marduk. Scholars interpret this tension between the old gods and the young, the sleeping and the rowdy, as a personification of the universal principles of Rest and Activity. Heidel summarizes the conflict in the Epic:

[21] Sandars, 38-39.

[22] Jacobsen, 169.

> The younger gods, being full of life and vitality, naturally enjoyed noisy, hilarious gatherings. These, however, caused serious distress to their old, inactive, and rest-loving parents and grandparents, Apsu and Tiamat. Peaceful means were tried to diminish the disturbing clamor, but without success.[23]

Upon this first and most fundamental conflict in the Epic, Jacobsen builds an impressive theory regarding the Mesopotamian's perception of reality. The older powers, Apsu and Tiamat, as we said before, stand for "inertia and rest," while Marduk and his generation stand for "energy and movement."[24] Jacobsen's entire interpretation, involving the historical-political atmosphere of Babylon around the time of the Epic's composition, need not concern us here, except to say that the meaning of the universe for the Mesopotamian, according to Jacobsen, is found in seeing *in the physical world itself* a distinction between inertia and activity.[25]

This distinguishing facility of the Mesopotamian mind works elsewhere, according to Jacobsen, and is of its very essence:

> The characteristic Mesopotamian boundness to the externals of situations in which the Numinous was encountered not only tended to circumscribe it and give it intransitive character, it also led to differentiation. The Numinous was the indwelling spirit and power of many phenomena and

[23] Heidel, 4.

[24] Jacobsen, 183.

[25] Ibid., 191: "As a view of world order this is in many ways impressive. It sees the universe as grounded in divine power and divine will: even those wills traditionally felt as older, more authoritative, or hostile, are unified under the leadership of a single ruler who governs through consultation, persuasion, and conviction. It is religiously of great profundity, leading in its picture of Marduk toward the aspects of awe and majesty. Moreover, it is intellectually admirable in providing a unifying concept of existence: political order pervades both nature and society. Finally, it is humanly satisfying: ultimate power is not estranged from mankind, but resides in gods in human form who act understandably. The universe is now moral and meaningful and expression of a creative intelligence with valid purpose: order and peace and prosperity."

> situations and it differed with each of them. Thus ancient Mesopotamian religion was conditioned to a pluralistic view, to polytheism, and to the multitude of gods and divine aspects that it recognized. Plurality of numinous power requires the ability to distinguish, evaluate, and choose; and here also the ancient Mesopotamian leaned heavily on external situation.[26]

This ability to see and differentiate *in the external situation itself* a real power and meaning allowed the Mesopotamian the intellectual freedom to speculate profoundly about the world around him, while still keeping his speculations in check by constantly grounding them to the physical situation before him.

Before concluding this section, it is worthwhile to examine in this context the phenomenon of *divination*, the belief that an observation of physical substances and events can lead to a real knowledge of the future. It is easy to see why, in the context of such a world vision as that presented by the *Enuma elish*, the Mesopotamian sage would pay close attention to physical events or oddities: if the government of the world is accomplished by the gods themselves, and if the gods have meaning, then the events brought about by their government must have meaning, even if it is not immediately comprehensible to us. The way to *make* seemingly trivial events comprehensible was, for the Mesopotamian, closer observation. Bottero states: "It seems that from very early there was a desire to go further by looking beyond the appearances for an internal connection between the two events which formed an oracle."[27] He comments later:

> In our eyes such "connections" do not exist. They are pure coincidences without importance. We have to believe (and we know it from other sources as well) that such was not the case with the ancient Mesopotamians, especially with their well-known

[26] Ibid., 11-12. This phenomenon will be of great importance in Chapter 3, in the discussion on the Medieval Mesopotamian preference for the works of Aristotle over those of the Platonists.

[27] Bottero, 132.

> doctrine of the world's government by the gods, and hence the preliminary fixing of the destinies, that is, the names, of all things by these gods.[28]

While we will discuss Bottero's identification between "name" and "destiny" in the next section, we may say here that there is *always*, for the Mesopotamian, a real reason for every event that occurs, whether this reason is known to human beings or not. Or, better, whether it is known to them *yet.* Oppenheim commenting on the practice of divination says, "Because of the belief that whatever happens within perception occurs not only due to specific if unknown causes, but also for the benefit of the observer to whom a supernatural agency is thereby revealing its intentions, the Akkadians of the Old Babylonian period began rather early to record such happenings."[29] In another work, Oppenheim translates what he calls a "Babylonian Diviner's Manual," which is just such a list of recordings of odd events ranging from "If bundles of reeds walk about in the countryside," to "If a wildcat opens its mouth and talks like a man."[30] A telling verse in this work is: "A sign that portends evil in the sky is (also) evil on earth; one that portends evil on earth is evil in the sky."[31]

We may conclude this section, then, by noting that this attitude toward the world requires a tremendous and profound *sensitivity* to surroundings. With this in place, and also with the *humility* of the human subject discussed above, the world becomes a wondrous and exciting place. To the sensitive Mesopotamian mind, then, *the physical world itself has real, true meaning*, and there is no need to posit another world, for example, the Platonic world of ideas, which gives meaning to this one. Moreover, the *wonder* or *curiosity* with which the Mesopotamian viewed the world expressed itself in a real, though realistic, desire to know as much as possible about the universe. This expressed itself, for example, in the long lists of the "divinatory manuals," which show

[28] Ibid., 133.

[29] Oppenheim, 210.

[30] A. Leo Oppenheim, "A Babylonian Diviner's Manual," in *Journal of Near Eastern Studies* 33.2 (1974): 203.

[31] Ibid., 204.

again the paradox of the greatness and the lowliness of the human race: though we wish to know everything, we can *only* know through a painstaking process of memory and sensory perception. Bottero concludes a section of his book: "[Divination] is a new characteristic that places next to the simple passive and detached knowledge of pure observation the desire to know *everything*: not only the observed reality but the possible; in other words the universal. This is a new characteristic that forces us to put forward the term Science."[32]

[32] Bottero, 36.

The Book of Genesis

Chapters 1-2

Revised Standard Version

Genesis, Chapter 1

[1] In the beginning God created the heavens and the earth.

[2] The earth was without form and void, and darkness was upon the face of the deep; and the Spirit of God was moving over the face of the waters.

[3] And God said, "Let there be light"; and there was light.

[4] And God saw that the light was good; and God separated the light from the darkness.

[5] God called the light Day, and the darkness he called Night. And there was evening and there was morning, one day.

[6] And God said, "Let there be a firmament in the midst of the waters, and let it separate the waters from the waters."

[7] And God made the firmament and separated the waters which were under the firmament from the waters which were above the firmament. And it was so.

[8] And God called the firmament Heaven. And there was evening and there was morning, a second day.

[9] And God said, "Let the waters under the heavens be gathered together into one place, and let the dry land appear." And it was so.

[10] God called the dry land Earth, and the waters that were gathered together he called Seas. And God saw that it was good.

[11] And God said, "Let the earth put forth vegetation, plants yielding seed, and fruit trees bearing fruit in which is their seed, each according to its kind, upon the earth." And it was so.

[12] The earth brought forth vegetation, plants yielding seed according to their own kinds, and trees bearing fruit in which is their seed, each according to its kind. And God saw that it was good.

[13] And there was evening and there was morning, a third day.

[14] And God said, "Let there be lights in the firmament of the heavens to separate the day from the night; and let them be for signs and for seasons and for days and years,

[15] and let them be lights in the firmament of the heavens to give light upon the earth." And it was so.
[16] And God made the two great lights, the greater light to rule the day, and the lesser light to rule the night; he made the stars also.
[17] And God set them in the firmament of the heavens to give light upon the earth,
[18] to rule over the day and over the night, and to separate the light from the darkness. And God saw that it was good.
[19] And there was evening and there was morning, a fourth day.
[20] And God said, "Let the waters bring forth swarms of living creatures, and let birds fly above the earth across the firmament of the heavens."
[21] So God created the great sea monsters and every living creature that moves, with which the waters swarm, according to their kinds, and every winged bird according to its kind. And God saw that it was good.
[22] And God blessed them, saying, "Be fruitful and multiply and fill the waters in the seas, and let birds multiply on the earth."
[23] And there was evening and there was morning, a fifth day.
[24] And God said, "Let the earth bring forth living creatures according to their kinds: cattle and creeping things and beasts of the earth according to their kinds." And it was so.
[25] And God made the beasts of the earth according to their kinds and the cattle according to their kinds, and everything that creeps upon the ground according to its kind. And God saw that it was good.
[26] Then God said, "Let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the earth, and over every creeping thing that creeps upon the earth."
[27] So God created man in his own image, in the image of God he created him; male and female he created them.
[28] And God blessed them, and God said to them, "Be fruitful and multiply, and fill the earth and subdue it; and have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth."

[29] And God said, "Behold, I have given you every plant yielding seed which is upon the face of all the earth, and every tree with seed in its fruit; you shall have them for food.
[30] And to every beast of the earth, and to every bird of the air, and to everything that creeps on the earth, everything that has the breath of life, I have given every green plant for food." And it was so.
[31] And God saw everything that he had made, and behold, it was very good. And there was evening and there was morning, a sixth day.

Genesis, Chapter 2

[1] Thus the heavens and the earth were finished, and all the host of them.
[2] And on the seventh day God finished his work which he had done, and he rested on the seventh day from all his work which he had done.
[3] So God blessed the seventh day and hallowed it, because on it God rested from all his work which he had done in creation.
[4] These are the generations of the heavens and the earth when they were created.
In the day that the LORD God made the earth and the heavens,
[5] when no plant of the field was yet in the earth and no herb of the field had yet sprung up -- for the LORD God had not caused it to rain upon the earth, and there was no man to till the ground;
[6] but a mist went up from the earth and watered the whole face of the ground --
[7] then the LORD God formed man of dust from the ground, and breathed into his nostrils the breath of life; and man became a living being.
[8] And the LORD God planted a garden in Eden, in the east; and there he put the man whom he had formed.
[9] And out of the ground the LORD God made to grow every tree that is pleasant to the sight and good for food, the tree of life also in the midst of the garden, and the tree of the knowledge of good and evil.
[10] A river flowed out of Eden to water the garden, and there it divided and became four rivers.

[11] The name of the first is Pishon; it is the one which flows around the whole land of Havilah, where there is gold;
[12] and the gold of that land is good; bdellium and onyx stone are there.
[13] The name of the second river is Gihon; it is the one which flows around the whole land of Cush.
[14] And the name of the third river is Tigris, which flows east of Assyria. And the fourth river is the Euphrates.
[15] The LORD God took the man and put him in the garden of Eden to till it and keep it.
[16] And the LORD God commanded the man, saying, "You may freely eat of every tree of the garden;
[17] but of the tree of the knowledge of good and evil you shall not eat, for in the day that you eat of it you shall die."
[18] Then the LORD God said, "It is not good that the man should be alone; I will make him a helper fit for him."
[19] So out of the ground the LORD God formed every beast of the field and every bird of the air, and brought them to the man to see what he would call them; and whatever the man called every living creature, that was its name.
[20] The man gave names to all cattle, and to the birds of the air, and to every beast of the field; but for the man there was not found a helper fit for him.
[21] So the LORD God caused a deep sleep to fall upon the man, and while he slept took one of his ribs and closed up its place with flesh;
[22] and the rib which the LORD God had taken from the man he made into a woman and brought her to the man.
[23] Then the man said, "This at last is bone of my bones
and flesh of my flesh;
she shall be called Woman,
because she was taken out of Man."
[24] Therefore a man leaves his father and his mother and cleaves to his wife, and they become one flesh.
[25] And the man and his wife were both naked, and were not ashamed.

On the Parts of Animals

Aristotle

Translated by William Ogle

Book I

Chapter 1

Every systematic science, the humblest and the noblest alike, seems to admit of two distinct kinds of proficiency; one of which may be properly called scientific knowledge of the subject, while the other is a kind of educational acquaintance with it. For an educated man should be able to form a fair off-hand judgement as to the goodness or badness of the method used by a professor in his exposition. To be educated is in fact to be able to do this; and even the man of universal education we deem to be such in virtue of his having this ability. It will, however, of course, be understood that we only ascribe universal education to one who in his own individual person is thus critical in all or nearly all branches of knowledge, and not to one who has a like ability merely in some special subject. For it is possible for a man to have this competence in some one branch of knowledge without having it in all.

It is plain then that, as in other sciences, so in that which inquires into nature, there must be certain canons, by reference to which a hearer shall be able to criticize the method of a professed exposition, quite independently of the question whether the statements made be true or false. Ought we, for instance (to give an illustration of what I mean), to begin by discussing each separate species-man, lion, ox, and the like-taking each kind in hand inde. pendently of the rest, or ought we rather to deal first with the attributes which they have in common in virtue of some common element of their nature, and proceed from this as a basis for the consideration of them separately? For genera that are quite distinct yet oftentimes present many identical phenomena, sleep, for instance, respiration, growth, decay, death, and other similar affections and conditions, which may be passed over for the present, as we are not yet prepared to treat of them with clearness and precision. Now it is plain that if we deal with each species independently of the rest, we shall frequently be obliged to repeat the same statements over and over again; for horse and dog and

man present, each and all, every one of the phenomena just enumerated. A discussion therefore of the attributes of each such species separately would necessarily involve frequent repetitions as to characters, themselves identical but recurring in animals specifically distinct. (Very possibly also there may be other characters which, though they present specific differences, yet come under one and the same category. For instance, flying, swimming, walking, creeping, are plainly specifically distinct, but yet are all forms of animal progression.) We must, then, have some clear understanding as to the manner in which our investigation is to be conducted; whether, I mean, we are first to deal with the common or generic characters, and afterwards to take into consideration special peculiarities; or whether we are to start straight off with the ultimate species. For as yet no definite rule has been laid down in this matter. So also there is a like uncertainty as to another point now to be mentioned. Ought the writer who deals with the works of nature to follow the plan adopted by the mathematicians in their astronomical demonstrations, and after considering the phenomena presented by animals, and their several parts, proceed subsequently to treat of the causes and the reason why; or ought he to follow some other method? And when these questions are answered, there yet remains another. The causes concerned in the generation of the works of nature are, as we see, more than one. There is the final cause and there is the motor cause. Now we must decide which of these two causes comes first, which second. Plainly, however, that cause is the first which we call the final one. For this is the Reason, and the Reason forms the starting-point, alike in the works of art and in works of nature. For consider how the physician or how the builder sets about his work. He starts by forming for himself a definite picture, in the one case perceptible to mind, in the other to sense, of his end-the physician of health, the builder of a house-and this he holds forward as the reason and explanation of each subsequent step that he takes, and of his acting in this or that way as the case may be. Now in the works of nature the good end and the final cause is still more dominant than in works of art such as these, nor is necessity a factor with the same significance in them all; though almost all writers, while they try to refer their origin to this cause,

do so without distinguishing the various senses in which the term necessity is used. For there is absolute necessity, manifested in eternal phenomena; and there is hypothetical necessity, manifested in everything that is generated by nature as in everything that is produced by art, be it a house or what it may. For if a house or other such final object is to be realized, it is necessary that such and such material shall exist; and it is necessary that first this then that shall be produced, and first this and then that set in motion, and so on in continuous succession, until the end and final result is reached, for the sake of which each prior thing is produced and exists. As with these productions of art, so also is it with the productions of nature. The mode of necessity, however, and the mode of ratiocination are different in natural science from what they are in the theoretical sciences; of which we have spoken elsewhere. For in the latter the starting-point is that which is; in the former that which is to be. For it is that which is yet to be-health, let us say, or a man-that, owing to its being of such and such characters, necessitates the pre-existence or previous production of this and that antecedent; and not this or that antecedent which, because it exists or has been generated, makes it necessary that health or a man is in, or shall come into, existence. Nor is it possible to track back the series of necessary antecedents to a starting-point, of which you can say that, existing itself from eternity, it has determined their existence as its consequent. These however again, are matters that have been dealt with in another treatise. There too it was stated in what cases absolute and hypothetical necessity exist; in what cases also the proposition expressing hypothetical necessity is simply convertible, and what cause it is that determines this convertibility.

Another matter which must not be passed over without consideration is, whether the proper subject of our exposition is that with which the ancient writers concerned themselves, namely, what is the process of formation of each animal; or whether it is not rather, what are the characters of a given creature when formed. For there is no small difference between these two views. The best course appears to be that we should follow the method already mentioned, and begin with the phenomena presented by

each group of animals, and, when this is done, proceed afterwards to state the causes of those phenomena, and to deal with their evolution. For elsewhere, as for instance in house building, this is the true sequence. The plan of the house, or the house, has this and that form; and because it has this and that form, therefore is its construction carried out in this or that manner. For the process of evolution is for the sake of the thing finally evolved, and not this for the sake of the process. Empedocles, then, was in error when he said that many of the characters presented by animals were merely the results of incidental occurrences during their development; for instance, that the backbone was divided as it is into vertebrae, because it happened to be broken owing to the contorted position of the foetus in the womb. In so saying he overlooked the fact that propagation implies a creative seed endowed with certain formative properties. Secondly, he neglected another fact, namely, that the parent animal pre-exists, not only in idea, but actually in time. For man is generated from man; and thus it is the possession of certain characters by the parent that determines the development of like characters in the child. The same statement holds good also for the operations of art, and even for those which are apparently spontaneous. For the same result as is produced by art may occur spontaneously. Spontaneity, for instance, may bring about the restoration of health. The products of art, however, require the pre-existence of an efficient cause homogeneous with themselves, such as the statuary's art, which must necessarily precede the statue; for this cannot possibly be produced spontaneously. Art indeed consists in the conception of the result to be produced before its realization in the material. As with spontaneity, so with chance; for this also produces the same result as art, and by the same process.

The fittest mode, then, of treatment is to say, a man has such and such parts, because the conception of a man includes their presence, and because they are necessary conditions of his existence, or, if we cannot quite say this, which would be best of all, then the next thing to it, namely, that it is either quite impossible for him to exist without them, or, at any rate, that it is better for him that they should be there; and their existence

involves the existence of other antecedents. Thus we should say, because man is an animal with such and such characters, therefore is the process of his development necessarily such as it is; and therefore is it accomplished in such and such an order, this part being formed first, that next, and so on in succession; and after a like fashion should we explain the evolution of all other works of nature.

Now that with which the ancient writers, who first philosophized about Nature, busied themselves, was the material principle and the material cause. They inquired what this is, and what its character; how the universe is generated out of it, and by what motor influence, whether, for instance, by antagonism or friendship, whether by intelligence or spontaneous action, the substratum of matter being assumed to have certain inseparable properties; fire, for instance, to have a hot nature, earth a cold one; the former to be light, the latter heavy. For even the genesis of the universe is thus explained by them. After a like fashion do they deal also with the development of plants and of animals. They say, for instance, that the water contained in the body causes by its currents the formation of the stomach and the other receptacles of food or of excretion; and that the breath by its passage breaks open the outlets of the nostrils; air and water being the materials of which bodies are made; for all represent nature as composed of such or similar substances.

But if men and animals and their several parts are natural phenomena, then the natural philosopher must take into consideration not merely the ultimate substances of which they are made, but also flesh, bone, blood, and all other homogeneous parts; not only these, but also the heterogeneous parts, such as face, hand, foot; and must examine how each of these comes to be what it is, and in virtue of what force. For to say what are the ultimate substances out of which an animal is formed, to state, for instance, that it is made of fire or earth, is no more sufficient than would be a similar account in the case of a couch or the like. For we should not be content with saying that the couch was made of bronze or wood or whatever it might be, but should try to describe

its design or mode of composition in preference to the material; or, if we did deal with the material, it would at any rate be with the concretion of material and form. For a couch is such and such a form embodied in this or that matter, or such and such a matter with this or that form; so that its shape and structure must be included in our description. For the formal nature is of greater importance than the material nature.

Does, then, configuration and colour constitute the essence of the various animals and of their several parts? For if so, what Democritus says will be strictly correct. For such appears to have been his notion. At any rate he says that it is evident to every one what form it is that makes the man, seeing that he is recognizable by his shape and colour. And yet a dead body has exactly the same configuration as a living one; but for all that is not a man. So also no hand of bronze or wood or constituted in any but the appropriate way can possibly be a hand in more than name. For like a physician in a painting, or like a flute in a sculpture, in spite of its name it will be unable to do the office which that name implies. Precisely in the same way no part of a dead body, such I mean as its eye or its hand, is really an eye or a hand. To say, then, that shape and colour constitute the animal is an inadequate statement, and is much the same as if a woodcarver were to insist that the hand he had cut out was really a hand. Yet the physiologists, when they give an account of the development and causes of the animal form, speak very much like such a craftsman. What, however, I would ask, are the forces by which the hand or the body was fashioned into its shape? The woodcarver will perhaps say, by the axe or the auger; the physiologist, by air and by earth. Of these two answers the artificer's is the better, but it is nevertheless insufficient. For it is not enough for him to say that by the stroke of his tool this part was formed into a concavity, that into a flat surface; but he must state the reasons why he struck his blow in such a way as to effect this, and what his final object was; namely, that the piece of wood should develop eventually into this or that shape. It is plain, then, that the teaching of the old physiologists is inadequate, and that the true method is to state what the definitive characters are that distinguish the animal as a whole; to

explain what it is both in substance and in form, and to deal after the same fashion with its several organs; in fact, to proceed in exactly the same way as we should do, were we giving a complete description of a couch.

If now this something that constitutes the form of the living being be the soul, or part of the soul, or something that without the soul cannot exist; as would seem to be the case, seeing at any rate that when the soul departs, what is left is no longer a living animal, and that none of the parts remain what they were before, excepting in mere configuration, like the animals that in the fable are turned into stone; if, I say, this be so, then it will come within the province of the natural philosopher to inform himself concerning the soul, and to treat of it, either in its entirety, or, at any rate, of that part of it which constitutes the essential character of an animal; and it will be his duty to say what this soul or this part of a soul is; and to discuss the attributes that attach to this essential character, especially as nature is spoken of in two senses, and the nature of a thing is either its matter or its essence; nature as essence including both the motor cause and the final cause. Now it is in the latter of these two senses that either the whole soul or some part of it constitutes the nature of an animal; and inasmuch as it is the presence of the soul that enables matter to constitute the animal nature, much more than it is the presence of matter which so enables the soul, the inquirer into nature is bound on every ground to treat of the soul rather than of the matter. For though the wood of which they are made constitutes the couch and the tripod, it only does so because it is capable of receiving such and such a form.

What has been said suggests the question, whether it is the whole soul or only some part of it, the consideration of which comes within the province of natural science. Now if it be of the whole soul that this should treat, then there is no place for any other philosophy beside it. For as it belongs in all cases to one and the same science to deal with correlated subjects-one and the same science, for instance, deals with sensation and with the objects of sense-and as therefore the intelligent soul and the objects of

intellect, being correlated, must belong to one and the same science, it follows that natural science will have to include the whole universe in its province. But perhaps it is not the whole soul, nor all its parts collectively, that constitutes the source of motion; but there may be one part, identical with that in plants, which is the source of growth, another, namely the sensory part, which is the source of change of quality, while still another, and this not the intellectual part, is the source of locomotion. I say not the intellectual part; for other animals than man have the power of locomotion, but in none but him is there intellect. Thus then it is plain that it is not of the whole soul that we have to treat. For it is not the whole soul that constitutes the animal nature, but only some part or parts of it. Moreover, it is impossible that any abstraction can form a subject of natural science, seeing that everything that Nature makes is means to an end. For just as human creations are the products of art, so living objects are manifest in the products of an analogous cause or principle, not external but internal, derived like the hot and the cold from the environing universe. And that the heaven, if it had an origin, was evolved and is maintained by such a cause, there is therefore even more reason to believe, than that mortal animals so originated. For order and definiteness are much more plainly manifest in the celestial bodies than in our own frame; while change and chance are characteristic of the perishable things of earth. Yet there are some who, while they allow that every animal exists and was generated by nature, nevertheless hold that the heaven was constructed to be what it is by chance and spontaneity; the heaven, in which not the faintest sign of haphazard or of disorder is discernible! Again, whenever there is plainly some final end, to which a motion tends should nothing stand in the way, we always say that such final end is the aim or purpose of the motion; and from this it is evident that there must be a something or other really existing, corresponding to what we call by the name of Nature. For a given germ does not give rise to any chance living being, nor spring from any chance one; but each germ springs from a definite parent and gives rise to a definite progeny. And thus it is the germ that is the ruling influence and fabricator of the offspring. For these it is by nature, the offspring being at any rate that which

in nature will spring from it. At the same time the offspring is anterior to the germ; for germ and perfected progeny are related as the developmental process and the result. Anterior, however, to both germ and product is the organism from which the germ was derived. For every germ implies two organisms, the parent and the progeny. For germ or seed is both the seed of the organism from which it came, of the horse, for instance, from which it was derived, and the seed of the organism that will eventually arise from it, of the mule, for example, which is developed from the seed of the horse. The same seed then is the seed both of the horse and of the mule, though in different ways as here set forth. Moreover, the seed is potentially that which will spring from it, and the relation of potentiality to actuality we know.

There are then two causes, namely, necessity and the final end. For many things are produced, simply as the results of necessity. It may, however, be asked, of what mode of necessity are we speaking when we say this. For it can be of neither of those two modes which are set forth in the philosophical treatises. There is, however, the third mode, in such things at any rate as are generated. For instance, we say that food is necessary; because an animal cannot possibly do without it. This third mode is what may be called hypothetical necessity. Here is another example of it. If a piece of wood is to be split with an axe, the axe must of necessity be hard; and, if hard, must of necessity be made of bronze or iron. Now exactly in the same way the body, which like the axe is an instrument-for both the body as a whole and its several parts individually have definite operations for which they are made-just in the same way, I say, the body, if it is to do its work, must of necessity be of such and such a character, and made of such and such materials.

It is plain then that there are two modes of causation, and that both of these must, so far as possible, be taken into account in explaining the works of nature, or that at any rate an attempt must be made to include them both; and that those who fail in this tell us in reality nothing about nature. For primary cause constitutes the nature of an animal much more than does its matter. There are

indeed passages in which even Empedocles hits upon this, and following the guidance of fact, finds himself constrained to speak of the ratio (olugos) as constituting the essence and real nature of things. Such, for instance, is the case when he explains what is a bone. For he does not merely describe its material, and say it is this one element, or those two or three elements, or a compound of all the elements, but states the ratio (olugos) of their combination. As with a bone, so manifestly is it with the flesh and all other similar parts.

The reason why our predecessors failed in hitting upon this method of treatment was, that they were not in possession of the notion of essence, nor of any definition of substance. The first who came near it was Democritus, and he was far from adopting it as a necessary method in natural science, but was merely brought to it, spite of himself, by constraint of facts. In the time of Socrates a nearer approach was made to the method. But at this period men gave up inquiring into the works of nature, and philosophers diverted their attention to political science and to the virtues which benefit mankind.

Of the method itself the following is an example. In dealing with respiration we must show that it takes place for such or such a final object; and we must also show that this and that part of the process is necessitated by this and that other stage of it. By necessity we shall sometimes mean hypothetical necessity, the necessity, that is, that the requisite antecedants shall be there, if the final end is to be reached; and sometimes absolute necessity, such necessity as that which connects substances and their inherent properties and characters. For the alternate discharge and re-entrance of heat and the inflow of air are necessary if we are to live. Here we have at once a necessity in the former of the two senses. But the alternation of heat and refrigeration produces of necessity an alternate admission and discharge of the outer air, and this is a necessity of the second kind.

In the foregoing we have an example of the method which we must adopt, and also an example of the kind of phenomena, the causes of which we have to investigate.

Chapter 5

Of things constituted by nature some are ungenerated, imperishable, and eternal, while others are subject to generation and decay. The former are excellent beyond compare and divine, but less accessible to knowledge. The evidence that might throw light on them, and on the problems which we long to solve respecting them, is furnished but scantily by sensation; whereas respecting perishable plants and animals we have abundant information, living as we do in their midst, and ample data may be collected concerning all their various kinds, if only we are willing to take sufficient pains. Both departments, however, have their special charm. The scanty conceptions to which we can attain of celestial things give us, from their excellence, more pleasure than all our knowledge of the world in which we live; just as a half glimpse of persons that we love is more delightful than a leisurely view of other things, whatever their number and dimensions. On the other hand, in certitude and in completeness our knowledge of terrestrial things has the advantage. Moreover, their greater nearness and affinity to us balances somewhat the loftier interest of the heavenly things that are the objects of the higher philosophy. Having already treated of the celestial world, as far as our conjectures could reach, we proceed to treat of animals, without omitting, to the best of our ability, any member of the kingdom, however ignoble. For if some have no graces to charm the sense, yet even these, by disclosing to intellectual perception the artistic spirit that designed them, give immense pleasure to all who can trace links of causation, and are inclined to philosophy. Indeed, it would be strange if mimic representations of them were attractive, because they disclose the mimetic skill of the painter or sculptor, and the original realities themselves were not more interesting, to all at any rate who have eyes to discern the reasons that determined their formation. We therefore must not recoil with childish aversion from the examination of the humbler animals. Every realm of nature is marvellous: and as Heraclitus,

when the strangers who came to visit him found him warming himself at the furnace in the kitchen and hesitated to go in, reported to have bidden them not to be afraid to enter, as even in that kitchen divinities were present, so we should venture on the study of every kind of animal without distaste; for each and all will reveal to us something natural and something beautiful. Absence of haphazard and conduciveness of everything to an end are to be found in Nature's works in the highest degree, and the resultant end of her generations and combinations is a form of the beautiful.

If any person thinks the examination of the rest of the animal kingdom an unworthy task, he must hold in like disesteem the study of man. For no one can look at the primordia of the human frame-blood, flesh, bones, vessels, and the like-without much repugnance. Moreover, when any one of the parts or structures, be it which it may, is under discussion, it must not be supposed that it is its material composition to which attention is being directed or which is the object of the discussion, but the relation of such part to the total form. Similarly, the true object of architecture is not bricks, mortar, or timber, but the house; and so the principal object of natural philosophy is not the material elements, but their composition, and the totality of the form, independently of which they have no existence.

The course of exposition must be first to state the attributes common to whole groups of animals, and then to attempt to give their explanation. Many groups, as already noticed, present common attributes, that is to say, in some cases absolutely identical affections, and absolutely identical organs,-feet, feathers, scales, and the like-while in other groups the affections and organs are only so far identical as that they are analogous. For instance, some groups have lungs, others have no lung, but an organ analogous to a lung in its place; some have blood, others have no blood, but a fluid analogous to blood, and with the same office. To treat of the common attributes in connexion with each individual group would involve, as already suggested, useless iteration. For many groups have common attributes. So much for this topic.

As every instrument and every bodily member subserves some partial end, that is to say, some special action, so the whole body must be destined to minister to some Plenary sphere of action. Thus the saw is made for sawing, for sawing is a function, and not sawing for the saw. Similarly, the body too must somehow or other be made for the soul, and each part of it for some subordinate function, to which it is adapted.

We have, then, first to describe the common functions, common, that is, to the whole animal kingdom, or to certain large groups, or to the members of a species. In other words, we have to describe the attributes common to all animals, or to assemblages, like the class of Birds, of closely allied groups differentiated by gradation, or to groups like Man not differentiated into subordinate groups. In the first case the common attributes may be called analogous, in the second generic, in the third specific.

When a function is ancillary to another, a like relation manifestly obtains between the organs which discharge these functions; and similarly, if one function is prior to and the end of another, their respective organs will stand to each other in the same relation. Thirdly, the existence of these parts involves that of other things as their necessary consequents.

Instances of what I mean by functions and affections are Reproduction, Growth, Copulation, Waking, Sleep, Locomotion, and other similar vital actions. Instances of what I mean by parts are Nose, Eye, Face, and other so-called members or limbs, and also the more elementary parts of which these are made. So much for the method to be pursued. Let us now try to set forth the causes of all vital phenomena, whether universal or particular, and in so doing let us follow that order of exposition which conforms, as we have indicated, to the order of nature.

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http://classics.mit.edu/Aristotle/parts_animals.1.i.html

The Principles of Nature

St. Thomas Aquinas

Translated by Gerard T. Campbell

Notice carefully that some thing can be although it is not, whereas another thing truly is. That which can be is called being in potency; that which already is, is called being in act. But there are two kinds of being: namely essential being or the substantial being of the thing (as, for example, to be a man) and this is to be absolutely. The other kind of being is accidental being (as, for example, to be a white man), and this is to be after-a-fashion or in some qualified way.

To each of these kinds of being (i.e. substantial being and accidental being) there is something which is in potency. For there is something which is in potency to be a man, namely, the sperm and the menstrual blood; and there is also something which is in potency to being white, namely, a man. And that which is in potency to substantial being just as much as that which is in potency to accidental being can be called matter; as, for example, the sperm is with respect to the man and the man, in respect to whiteness. But there is a difference. The matter which is in potency to substantial being is called the matter 'out of which' whereas the matter which is in potency to accidental being is called the matter 'in which'. Again, in a strict way of speaking, that which is in potency to substantial being is called prime matter, however, that which is in potency to accidental being is called the subject: This is why it is said that accidents are in a subject--and also why it is not said that substantial form is in a subject. And it is according to this notion that 'matter' differs from 'subject' because the subject does not have its being from what comes to it but has in itself complete being (as, for example, a man does not derive his being from his whiteness). But matter, on the other hand, does derive its being from what comes to it, since, of itself, it has incomplete being. Therefore, strictly speaking, (substantial) form gives being to matter, whereas accidents do not give being to a subject, but rather, the subject to the accidents. Sometimes, however (in popular terminology), one term is used for the other, that is, 'matter' for 'subject' and vice-versa.

Again, just as everything which is in potency can be called 'matter' in the same way everything by which something has being (either substantially or accidentally), can be called 'form'; for example, in man since he is potentially white, he becomes actually white through whiteness, and the sperm, since it is potentially man becomes actually man through the soul. And because it is the form which makes something to be in act, accordingly the form is called 'act'. Moreover, that which brings about substantial being in act is called 'substantial form', and that which brings about accidental being in act is called 'accidental form'.

Now since generation (coming-to-be) is a movement towards form, there are two kinds of generation which correspond to these two kinds of forms: absolute coming-to-be corresponds to substantial form-relative coming-to-be (coming-to-be-in-a-certain-way), corresponds to accidental form. For whenever substantial form is introduced, we say that something absolutely becomes (i.e. without qualification)--for example, a man becomes a man or a man comes-to-be. However, when accidental form is introduced, we do not say that something becomes absolutely--but rather that it becomes this--for example, when a man becomes white we do not say that he becomes a man or that a man has come-to-be but rather that the man becomes white or comes-to-be white. And there is a two-fold notion of corruption (passing away) which is opposed to this two-fold notion of generation (coming-to-be)--namely, absolute passing-away and relative passing away. Absolute generation (coming-to-be) and absolute corruption (passing away) exist only within the genus of substance. On the other hand relative generation and relative corruption (coming-to-be-and passing-away-in some way or other) are found in all of the other genera. And because generation is a kind of movement from non-being to being and, conversely, corruption from being to non-being, it is not from just any kind of non-being that generation comes but from non-being which is being in potency--just as, for example, the statue comes from bronze which is statue in potency, not in act.

And, therefore, in order that generation (coming-to-be) come about, three things are necessary: namely, a potential something which is the matter, and not-being in act which is the

privation, and that through which it becomes in act, namely, the form. Let us take an example: when a statue-is made from bronze, the bronze which is in potency for the form of the statue is 'the matter'; the privation is the shapelessness or the lack of the form (of statue in the molten bronze); the shape by which we call it a statue is the form. The form of statue, however, is not the substantial form, because the bronze before the coming-to-be of this form (of statue) has being in act, and its being does not depend upon this shape (of statue) which is an accidental form. All artificial forms are accidental forms. For art only operates upon those things already constituted in being by nature.

There are, therefore, three principles of nature, and these are matter, form, and privation. One of these principles, namely, the form, is that towards which coming-to-be moves: the other two are on the side of that from which coming-to-be arises. Hence matter and privation are in the same subject but seen from different viewpoints. For it is the same subject which is both bronze and unshaped (with respect to the statue) before the advent of the form--but it is for one reason that we call it bronze and for another reason that we call it unshaped. Hence privation is called a principle, not essentially but accidentally, because it coincides with the matter; for example, we say that a doctor builds something accidentally, for the doctor builds something not in so far as he is a doctor, but in so far as he is a builder and builder coincides with doctor in one subject. Now accidents are of two kinds. There are necessary accidents which are not separated from the thing, as, for example, risibility from man; and there are non-necessary accidents which are separated, such as whiteness from man. So although privation is an accidental principle, it does not follow that it is not necessary for coming-to-be. For matter is never without privation: for in so far as the matter is under one form it has the privation of another form and viceversa. For example, in fire there is the privation of air and in air the privation of fire.

It should be noticed that although coming-to-be arises from not-being, we do not say that negation is its principle, but rather, privation; and this is because negation does not determine the subject for itself. Not-seeing can be said even of non-beings as, for example, "Chimeras do not see." Likewise it can be said of

beings which are not intended by nature to have sight, such as a stone. But privation is said only of a determinate subject which is intended by nature to have a given state: thus blindness, for example, is only said of those things which are intended by nature to see. And because coming-to-be does not arise from absolute non-being but from non-being which is in a certain subject, and not in just any subject but in a determined one, (for it is not from just any non-burning thing that fire comes about, but from a non-burning thing which by nature can become the form of fire)--it is because of this that privation is a principle. But in this, privation as a principle differs from the other principles because the others are principles both in being and becoming. For that this should become a statue it is necessary that there be bronze and, ultimately, the shape of the statue: and, moreover, once it is a statue, it is again necessary that both of these exist. But privation is a principle in becoming and not in being, for while the statue is becoming it cannot be a statue. If it were a statue, it could not be becoming one, because what is becoming is only in successive stages, as are time and motion. But from that which already is a statue, there is not the privation of statue in it. Because affirmation and negation cannot exist simultaneously, similarly neither can the state and the privation of that state. And so privation is an accidental principle in the sense explained above; the other two are essential principles.

From what has already been said, it is evident that matter differs from form and from privation according to definition. For matter is that in which both form and privation are understood, just as both a shape and a lack of a shape are understood in the bronze. And sometimes the way in which we name the matter involves the notion of privation and sometimes it does not involve the notion of privation; for example, bronze, although it is the matter of the statue does not involve the notion of privation because when I say "bronze", the lack of a form or the lack of a shape is not included in my concept. On the other hand, flour, since it is the matter with respect to bread does involve in itself the privation of the form of bread, because when I say "flour" the lack of form or the disorganization opposed to the form of bread is signified. And because in coming-to-be the matter or the subject remains, but the privation does not, and neither does the

composite of matter and privation, accordingly, matter which does not involve the notion of privation remains; however, that matter which does involve the notion of privation, is transitory.

It should also be noted that some matter has a composition of form; for example, although the bronze is the matter with respect to the statue, nevertheless, the bronze itself is a composite of matter and form. Therefore, bronze cannot be called prime matter because it has a matter. Only that matter which can be understood without any form and privation, but which is the subject of both form and privation, is called prime matter because there is not any other matter prior to it. And this prime matter is also called "hyle".

Because all knowledge and every definition is through the form, therefore, prime matter cannot be known or defined by itself, but by the composite: and so we say that prime matter is that which is related to all forms and all privations like the bronze is related to the statue and to the privation of some figure. And prime matter here means prime in an absolute way. For something can also be called primary with respect to a certain genus, such as water being the prime matter in the genus of liquids. Nevertheless, water is not prime in an absolute way, because it is a composite of matter and form; hence it has a matter prior to it.

Again it should be noted that both prime matter and form neither come-to-be nor pass-away because all coming-to-be is from something to something. Now that from which the coming-to-be is from is the matter; and that to which the coming-to-be is to is the form. Therefore, if the matter or the form also come-to-be, there would be a matter of the matter and a form of the form ad infinitum. Hence, strictly speaking, only the composite comes-to-be.

Again it should be noted that prime matter is said to be numerically one in all things. But "numerically one" can be said in two ways: first of all, of that which has a one determined form in number as, for example, Socrates. Now prime matter is not said to be numerically one in this way since, in itself, it does not have any one form. Secondly, something can also be said to be numerically one which is without the dispositions which would make it differ according to number. And it is in this way that prime matter is said

to be numerically one, because its concept involves the lack of all of the dispositions which account for differentiation in number.

And finally it should be noted that although the concept of prime matter does not include any form or privation, just as in the concept of bronze there is included neither a shape nor the lack of a shape, nevertheless prime matter is never without some form and privation. For sometimes it is under one form and sometimes under another form. But prime matter cannot exist by itself alone, because by its very definition it does not have any form, and so does not have any actual existence, sincebeing in act is only through the form. But prime matter is only in potency. And, therefore, anything whatsoever that exists in act cannot be called prime matter.

From what has been said it is evident that there are three principles of nature, namely, matter, form, and privation. But these three are not sufficient to explain coming-to-be. For whatever is in potency cannot reduce itself to act: for example, the bronze which is a statue in potency does not make itself a statue, but requires an agent which draws out from potency to act the form of the statue. Neither can the form draw itself into act from potency. And here I am speaking of the form generated which we call the term of generation. For the form does not exist unless it exists in fact: the agent, however, exists in becoming, that is, while the thing is coming-to-be. Besides the matter and the form, therefore, there must exist some other principle which acts, and this is called the efficient cause or, the moving cause, or the agent, or the principle from whence the movement exists.

And because, as Aristotle points out in Bk. II of the Metaphysics, everything which acts, acts only when intending something, a fourth principle must also be posited--namely, that which is intended by the agent, and this is called the end. And it should be noted that although every agent whether natural or voluntary intends an end, nevertheless it does not follow that every agent knows the end or deliberates about the end. For to know the end is necessary only in those things whose actions are not determined but which can move towards opposites, as is the case with voluntary agents; for these (voluntary agents) it is necessary that they know the end through which they determine

their actions. In natural agents, however, their actions are determined, hence it is not necessary to choose those things (means) which are for the end. We may use the example given by Avicenna of the cithara (a musical instrument resembling a lyre) player who does not have to deliberate about each note of a chord since the notes are determined within it, for should someone deliberate, there would be a delay between the notes which would be discordant. All of this can be seen more clearly with respect to voluntary agents who deliberate than with natural agents--and, accordingly, it is evident a fortiori that if the voluntary agent whose deliberation is more evident, does not always deliberate, then certainly neither does the natural agent. It is therefore possible for a natural agent to intend an end without deliberation and this intending is nothing other than having a natural inclination towards something.

From what has been said it is evident that there are four causes, namely, the material, the efficient, the formal, and the final. Now although principle and cause are spoken of in a quasi-convertible way, as is said in Bk. V of the Metaphysics, nevertheless, in the Physics, Aristotle sets down four causes and three principles. Furthermore, he accepts as causes just as much extrinsic as intrinsic ones. Matter and form are called intrinsic causes of the thing due to the fact that they are the constitutive parts of the thing. The efficient and the final causes are called extrinsic causes because they are outside of the thing. But he accepts only the intrinsic causes as principles. Moreover, privation is not named among the causes because it is an accidental principle, as was said earlier. And when we speak of the four causes, we mean the essential causes to which, however, accidental causes are reduced because everything which is accidental is reduced to that which is essential.

But although Aristotle considers principles as intrinsic causes in Bk. I of the Physics, nevertheless, as he says in Bk. XI of the Metaphysics (this is today Bk. XII, 11 70b22-30), "principle" is properly said of extrinsic causes and "elements" of those causes which are the parts of the thing, that is, of the instrinsic causes. However "cause" is used with respect to both, although sometimes one term is used for the other; for every cause can be called a

principle and every principle, a cause. But, the notion of cause seems to add something over and above what is commonly called principle, because that which is first, whether or not something posterior follows from it, can be called a principle, just as the artisan is called the principle of the knife because a knife comes into being as a result of his activity: but when something is moved from blackness to whiteness, blackness is called the principle of that movement (and universally, everything from which a movement begins is called a principle), nevertheless, blackness is not that from which the being of whiteness follows. But "cause" is said only of that thing which is first from which a posterior thing follows in being (that is, with real dependence). Hence, a cause is that from the being of which another being follows. Accordingly, that which is first from which the movement begins cannot be called a cause essentially (per se) even if it is called a principle. This is the reason privation is placed among the principles but not among the causes, because privation is that from which the coming-to-be begins. But privation can also be called a cause per accidens, in so far as it coincides with the matter, as was explained earlier.

Moreover, the term "element" is used properly only of the causes from which the composition of the thing results--which, properly speaking, are material causes. And again, not from just any material cause whatsoever but from that from which results the primary composition of the thing; for example, we do not say that the limbs are the elements of the man because the limbs are themselves composed of other things. But we do call earth and water elements because these are not composed of other bodies--but from these elements results the primary composition of natural bodies. Thus Aristotle in Bk. V of the Metaphysics says that "an element is that from which a thing is primarily composed, and is in the thing, and is not divided according to the form". The explanation of the first part of this definition namely, "that from which a thing is primarily composed", is already clear from what has been said above. The second part, namely, "and is in the thing", is placed in the definition in order to differentiate (the element from) that other matter (prime matter) which totally passes-away through coming-to-be: for example, the bread is the matter of

blood, but blood only comes-to-be if the bread passes-away; hence the bread does not remain in the blood and so the bread cannot be called an element of blood. But for it to be an element it must remain in some way, since it does not entirely pass-away, as is said in the treatise On Generation. The third part of the definition, namely, "and is not divided according to the form" is placed in the definition to differentiate the element from those things which have diverse parts in form, that is, in species; for example, the hand, whose parts are flesh and bone, but which differ according to species; for example, any part whatsoever of water is water. It is not necessary to the being of the element to be not divided according to quantity, it is sufficient if it be not divided according to species. If something is also not divided in any way, it is called an element, as letters are said to be the elements of words. Accordingly, it is evident from what has been said that "principle" in some way in which it is used implies more than "cause", and "cause", more than "element"--and this is what the Commentator (Averroes) says in his commentary on Bk. V of the Metaphysics.

Having seen that there are four genera of causes, it should be noted that it is not impossible for a same thing to have several causes, such as the statue whose cause is bronze and the artisan, but the artisan as the efficient cause, bronze as the material cause. Nor is it impossible that a same thing be the cause of contraries, just as the helmsman is the cause of the safety of the ship and of its sinking; but of the latter by his absence, and of the former by his presence.

It should also be noted that it is possible that a same thing be cause and caused with respect to the same thing but in different ways: for example, walking is the cause of health in the way of efficient causality, but health is the cause of walking in the way of final causality, for sometimes walking is done for the sake of health. Another example is that the body is the matter of the soul, while the soul is the form of the body. The efficient cause is called a cause with respect to the end, for the end can only exist in act through the operation of the agent: but the end is called the cause of the efficient cause, for the efficient cause operates only through the intention of the end. Hence the efficient cause is cause of that which is the end, as, for example, walking for the sake of health;

nevertheless the efficient cause does not make the end, that is, it does not make the end to be a final cause. A doctor, for example, makes health to be in act, nevertheless, he does not make health be an end. The end, however, is not the cause of that which is the efficient cause, but it is the cause that an efficient cause be an efficient cause. For health does not make the doctor to be a doctor (and I am speaking of the health resulting from the operation of the doctor) but it does make the doctor be an efficient cause. Similarly the end makes the matter be the material cause and the form be the formal cause, since the matter receives the form only for an end, and the form perfects the matter only for and end. Hence the end is called the cause of causes because it is the cause of the causality in all causes. Also matter is called the cause of the form in so far as the form exists only in matter; and similarly the form is the cause of the matter, in so far as matter has being in act only through the form. For matter and form are said to be mutually related as is said in Bk. II of the Physics. For they are said in relation to the composite, as are parts in relation to the whole, and the simple in relation to the composite.

But because every cause, in so far as it is a cause, is naturally prior to what is caused, it should be noted that "prior" is said in two ways, as Aristotle says in Bk. XVI of On Animals (c.f. On the Generation of Animals II, 6, 742a21). Through this diversity, something can be called both prior and posterior and cause and caused with respect to the same thing. For something is called prior to another in generation and time or prior in substance and completeness. Therefore, since the operation of nature is from the imperfect to the perfect and from the incomplete to the complete, the imperfect is prior to the perfect according to generation and time, but the perfect is prior to the imperfect according to substance: for example, it can be said that the man is prior to the boy in substance and completeness, but the boy is prior to the man in generation and time. But, although in things capable of coming-to-be, the imperfect is prior to the perfect and potency is prior to act--considering that in any subject that what is prior is imperfect rather than perfect and in potency rather than in act--nevertheless, absolutely speaking, it is necessary that what is in act and perfect be prior; because what reduces potency to act is in act and what

perfects the imperfect is perfect. The matter is prior to the form in generation and time, for that to which something comes is prior to that which comes to it. But the form is prior to the matter in substance and complete being because the matter has complete being only through the form. Similarly the efficient cause is prior to the end in generation and time, since the movement towards the end is brought about by the efficient cause; but the end is prior to the efficient cause, in so far as it is efficient cause, in substance and completeness, since the action of the efficient cause brings about completeness only through the end. Accordingly, these two causes, the material and the efficient are prior by way of generation; but the form and the end are prior by way of perfection.

And it should be noted that there are two kinds of necessity, namely, absolute necessity and conditional necessity. That necessity is absolute which proceeds from prior causes in the order of generation, and these are the material and the efficient causes; for example the necessity of death which comes about from matter, namely from the disposition of contrary components--and it is called absolute because there is no impediment to it. This necessity is also called the necessity of matter. On the other hand, conditional necessity proceeds from causes which are posterior in generation, namely, from the form and the end; for example, we say that it is necessary that there be conception if a man is to be generated. And this necessity is also called conditional, because it is not absolutely necessary that this woman conceive but only under this condition, namely, if a man is to be generated. And this necessity is called the necessity of the end.

And it should be noted that three of the causes, namely, the form, the end and the efficient cause, can coincide in one thing as is evident in the coming-to-be of fire. For fire brings fire to be, therefore fire is the efficient cause in so far as it brings to be; and again, fire is the form in so far as it makes to be in act what before was in potency; and again it is the end in so far as it is the intention of the agent and in so far as the operation of the agent is terminated in it. But there are two kinds of ends, namely, the end of the generation and the end of the thing generated, such as is evident in the generation of a knife: for the form of a knife is the end of the generation, but cutting, which is the operation of the

knife, is the end of the thing generated, that is, the knife. However, sometimes the end of the generation coincides with the other two above-mentioned causes (the form and the efficient cause), namely, when the generation is of what is similar in species; for example, when a man generates a man or an olive tree generates an olive tree which (coincidence of form, efficient cause, and end) cannot be understood of the end of the thing generated. Nevertheless it should be noted that the end is identical with the form numerically, because it is the same something numerically which is the form generated and is the end of generation. But the end of the generation is not identical with the efficient cause in the same number but in the same species. For it is impossible that the maker and the thing made be numerically the same, but they can be specifically the same; for example, when a man generates a man, the man generating and the man generated are different by number but of the same species. However, the matter cannot coincide with the other causes because the matter by the fact that it is a being in potency, has the notion of imperfection; but the other causes, since they are in act, involve the notion of perfection; moreover, the perfect and the imperfect do not coincide in the same thing.

Accordingly, having seen that there are four causes, namely, the efficient, the material, the formal, and the final it should be known that these same causes are divided in many ways. There can be prior cause and posterior cause, as when we say that both the art and the doctor are the cause of health, but the art is the prior cause and the doctor the posterior cause. And the same division holds for the formal cause and the other causes. And notice carefully that we should always lead back a question to the first cause. For example, if we ask "why is this man healthy?" the answer is "Because the doctor healed him" And so we should ask again, "By what means did the doctor heal him?"--"Through the act of healing which he possesses."

It should also be noted that posterior cause is also called proximate cause and prior cause, remote cause. Hence these two divisions of causes--prior and posterior, remote and proximate--signify the same thing. However, it should be observed that always what is more universal is called remote cause, what is more

particular is called proximate cause. For example, we say that the proximate form of man is his definition, namely, rational mortal animal; but animal is more remote and substance again more remote. And similarly the proximate matter of the statue is bronze, but the remote matter is metal and the again more remote is body.

Again, (according to another division) of causes, some are essential and some are accidental. A cause is called essential which is the cause of something in so far as it is this kind of thing--for example, the builder is the cause of the house and the wood is the matter of the bench. A cause is called accidental which happens (to coincide with) an essential cause-for example, when we say that the grammarian; builds (a house). For the grammarian is called a cause of the building accidentally, for he does so not in so far as he is grammarian, but in so far as he is builder and it happens that he be a grammarian. And the case is similar in the other causes.

Again, (according to another division) of causes, certain ones are simple, others are composite. A cause is called simple when what is the essential cause is alone called cause or also when what is the accidental cause is alone called cause--for example if we say that the builder is the cause of the house and, similarly, if we say the doctor is the cause of the house. However a cause is called composite when both are said to be causes--for example, if we say the doctor-builder is the cause of the house. A cause can also be called simple in the way in which Avicenna explains it: that which causes without being united to another, as the bronze of statue--for the statue is of bronze without the addition of any other matter--and just as it is said that the doctor produces health or that fire produces heat. However he calls a cause composite when many things must come together in that which is a cause, just as one man is not the cause of the movement of the ship but many and as one stone is not the matter of the house, but many.

Again, (according to another division) of causes, some are actual and others are potential. An actual cause is one which actually causes a thing, as the builder when he is building, or the bronze when a statue is made of it. A potential cause is one which, although it is not causing the thing in act, nevertheless can cause it, as the builder while he is not building. And it should be noted that in speaking of actual causes it is necessary that the cause and the

caused exist simultaneously, such that if one is, the other must also be. For if a builder be in act, it is necessary that he build. And if there is building in act, there must be a builder in act. But this is not necessary in causes which are only potential. And it should be noted moreover that a universal cause is related to a universal effect, while a singular cause is related to a singular effect, just as we say that builder is the cause of house and this builder is the cause of this house.

It should also be noted that in speaking of the intrinsic principle, namely, matter and form, there is an agreement and difference of principles according to the agreement and difference of what results from the principles. For certain things are numerically the same, such as Socrates and this man (in pointing at Socrates). Other things are numerically diverse but the same in species, such as Socrates and Plato, who although they agree as men (human species) nevertheless, differ by number. Also certain things differ according to species but we are the same according to genus; for example, man and ass are both in the genus animal. Again certain things are diverse in genus but are the same only according to analogy; such as substance and quantity, which do not agree in any genus but which are brought together only according to analogy. For they are found together only in that which is being; being, however is not a genus, since it is not predicated univocally, but analogously.

In order to understand this, however, it should be known that something is predicated of many in three ways: univocally, equivocally and analogously. A univocal predication occurs when one thing is predicated according to the same name and according to the same nature, that is, the same definition, as "animal" is predicated of "man" and "ass". For both of these are called "animal" and each of them is a living substance capable of sensation, which is the definition of animal. Equivocal predication occurs when something is predicated of others according to the same name and according to different natures, as "dog" is said of a "barking animal" and a "stellar constellation", which things agree only in name and not in definition or signification; for that which is signified by the name is the definition, as is said in Bk. IV of the Metaphysics. An analogical predication occurs when one thing is

predicated of many, which are of different natures, but of which one some thing is attributed to them, as "healthy" is said of the "animal body", and of "urine", and of the "medicine" but "healthy" does not signify exactly the same thing in all of them. For "healthy" is said of "urine" as of a sign of good health, of "the body", as of its subject, of "the medicine" as of a cause. Nevertheless, all of these natures are attributed to a one end, namely, health. For sometimes those things which are brought together according to analogy, that is in proportion, or comparison, or agreement, are attributed to one end, as is evident in the above example; sometimes in one agent, as "doctor" is said both of one who operates through art and of one who operates without art, such as the midwife--and the same also holds for instruments, but through attribution to a one agent which is the art of medicine. Also sometimes the analogy is based through attribution to a one subject as when "being" is said of substance and of quantity and of quality, and of the other predicaments. For it is not for exactly the same reason that substance is said of being, and quantity, and the others--but all of them are called being by the fact that they are attributed to substance, which is the subject of the others. And, therefore, being is said primarily of substance and secondarily of the others. Accordingly, being is not the genus of substance and quantity because no genus is predicated primarily and secondarily of its species. Being is predicated analogously. And it is in this light that we say that substance and quantity differ in genus, but are the same according to analogy.

Wherefore, of those things which are numerically one, both the form and the matter are numerically one, as in the case of Tullius and of Cicero. Moreover, of those things which are the same specifically, but differ by number, both the matter and the form are not the same numerically but specifically as in the case of Socrates and of Plato. And similarly, of those things which are the same generically, their principles are generically the same, as in the case of the soul and the body of an ass and of a horse which differ specifically but are the same generically. And it is also similar for those things which agree only according to analogy, for their principles are similar only according to analogy or proportion. For matter, form, and privation, or potency and act are principles of

substance and of the other genera. Nevertheless, the matter of substance and of quantity (and similarity with respect to form and privation) differ generically, but agree only according to a proportion which consists in this--just as the matter of substance is related to substance in the nature of matter, so is the matter of quantity related to quantity. However, just as substance is the cause of all the other genera, so the principles of substance are the principles of all the other genera.

Dedication to the Grand Duke of Tuscany

Galileo

Most Serene Grand Duke:

Though the difference between man and the other animals is enormous, yet one might say reasonably that it is little less than the difference among men themselves. What is the ration of one to a thousand? Yet it is proverbial that one man is worth a thousand where a thousand are of less value than a single one. Such differences depend upon diverse mental abilities, and I reduce them to the difference between being or not being a philosopher; for philosophy, as the proper nutriment of those who can feed upon it, does in fact distinguish that single man from the common herd in a greater or less degree of merit according as his diet varies.

He who looks the higher is the more highly distinguished, and turning over the great book of nature (which is the proper object of philosophy) is the way to elevate one's gaze. And though whatever we read in that book is the creation of the omnipotent Craftsman, and is accordingly excellently proportioned, nevertheless that part is more suitable and most worthy which makes His work and His craftsmanship most evident to our view. The constitution of the universe I believe may be set in first place among all natural things that can be known, for coming before all others in grandeur by reason of its universal content, it must also stand above them all in nobility as their rule and standard. Therefore if any men might claim extreme distinction in intellect above all mankind, Ptolmey and Copernicus were such men, whose gaze was thus raised on high and who philosophized about the constitution of the world. These dialogues of mine revolving principally around their works, it seemed to me that I should not dedicate them to anyone except Your Highness. For they set forth the teaching of these two men whom I consider the greatest minds ever to have left us such contemplations in their works; and, in order to avoid any loss of greatness, must be placed under the protection of the greatest support I know from which they can receive fame and patronage. And if those two men have shed so much light upon my understanding that this work of mine can in large part be called theirs, it may properly be said also to belong to Your Highness, whose liberal munificence has not only given me leisure and peace for writing, but whose effective assistance, never tired of favoring me, is the means by which it finally reaches publication.

Therefore may Your Highness accept it with your customary beneficence; and if anything is to be found in it from which lovers of truth can draw the fruit of greater knowledge and utility, let them acknowledge

it as coming from you who are so accustomed to being of assistance that in your happy dominions no man feels the widespread distress existing in the world or suffers anything that disturbs him. Wishing you prosperity and continual increase in your pious and magnanimous practices, I most humbly offer your reverence.

Your Most Serene Highness's most humble and most devoted servant and subject,
Galileo Galilei

To the Discerning Reader

Galileo

Several years ago there was published in Rome a salutary edict which, in order to obviaie the dangerous tendencies of our present age, imposed a seasonable silence upon the Pythagorean opinion that the earth moves There were those who impudently asserted that this decree had its origin not injudicious inquire, but in passion none too well informed Complaints were to be heard that advisers who were totally unskilled at astronomical observations ought not to clip the wings of reflective intellects by means of rash prohibitions.

Upon hearing such carping insolence, my eal could not be contained Being thoroughly informed about that prudent determination, I decided to appear openly in the theater of the world as a witness of the sober truth. I was at that time in Rome; I was not only received by the most eminent prelates of that Court, but had their applause; indeed this decree was not published without some previous notice of it having been given to me. Therefore I propose in the present work to show to foreign nations that as much is understood of this matter in Italy, and pariicularly in Rome, as transalpine diligence can ever have imagined Collecting all the reflections thai properly concern the Copernican system, I shall make it known that everything was brought before the attention of the Roman censorship, and that there proceed from this clime not only dogmas for the welfare of the soul, but ingenious discoveries for the delight of the mind as well.

To this end I have taken the Copernican side in the discourse, proceeding as with a pure mathematical hypothesis and striving by every artipee to represent it as superior to supposing the earth motionless–not, indeed absolutely, but as against the arguments of some professed Peripatetics. These men indeed deserve not even that name, for they do not walk about; they are content to adore the shadows, philosophizing not with due circumspection but merely from having memorized a fow ill-understood principles.

Three principal headings are treated First, I shall try to show that all experiments practicable upon the earth are inszyfficient measures for proving its mobility, since they are indiferently adaptable to an earth in motion or at rest. I hope in so doing to reveal many observations unknown to the ancients. Secondly, the celestial phenomena will be examined strengthening the Copernican hypothesis until it might seem that this must triumph absolutely. Here new reflections are adjoined which might be used in order to simplfy astronomy, though not because of any necess ire importeded by nature. In the third place, I shall propose an ingenious speculation. It happens that long ago I said that the unsolved problem of the ocean tides might receive some light from assuming the motion of the earth. This assertion of mine, passing by word of mouth, found loving fathers who adopted it as a child of their own ingenuity. Now, so that no stranger may ever a who, arming himself with our weapons, shall charge us with want of attention to such an important matter, I have thought it good to reveal those probabilities which might render this plausible, given that the earth moves.

I hope that from these considerations the world will come to know that if other nations have navigated more, we have not theorized less. It is not from failing to take count of what others have thought that we have yielded to asserting that the earth is motionless, and holding the contrary to be a mere mathematical caprice, but (if for nothing else) for those reasons that are supplied by piety, religion, the knowledge of Divine Omnipotence, and a consciousness of the limitations of the human mind I have thought it most appropriate to explain these concepts in the form of dialogues, which, no! being restricted to the rigorous observance of mathematical laws, make room also for digressions which are sometimes no less interesting than the principal argument.

Many years ago I was often to be found in the marvelous city of Venice, in discussions with Signore Giovanni Francesco Sagredo, a man of noble extraction and trenchant wit. Prom Florence came Signore Filippo Salviati, the least of whose glories were the eminence of his blood and the magnfficence of his fortune. His was a sublime intellect which fed no more hungrily upon any pleasure than it did upon fine meditations. I often talked with these two of such matters in the presence of a certain Peripatetic philosopher whose greatest obstacle in apprehending the truth seemed to be the reputation he had acquired by his interpretations of Aristotle.

Now, since bitter death has deprived Venice and Florence of those two great luminaries in the very meridian of their years, I have resolved to make their fame live on in these pages, so far as my poor abilities will permit, by introducing them as interlocutors in the present

argument. (Nor shall the good Peripatetic lack a place; because of his excessive affection toward the Commentaries of Simplicius,I have thought fit to leave him under the name of the author he so much revered, without mentioning his own) May it please those two great souls, ever venerable to my heart, to accept this public monument of my undying love. And may the memory of their eloquence assist me in delivering to posterity the promised reflections.

It happened that several discussions had taken place casually at various times among these gentlemen, and had rather whetted than satisfied their thirst for learning. Hence very wisely they resolved to meet together on certain days during which, setting aside all other business, they might apply themselves more methodically to the contemplation ofthe wonders of God in the heavens and upon the earth. They met in the palace of the illustrious Sagredo; and, after the customary but brief exchange of compliments, Saiviati commenced as follows.

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Newton's Preface to the First Edition of the Principia

Since the ancients (as we are told by Pappas), made great account of the science of mechanics in the investigation of natural things; and the moderns, lying aside substantial forms and occult qualities, have endeavoured to subject the phænomena of nature to the laws of mathematics, I have in this treatise cultivated mathematics so far as it regards philosophy. The ancients considered mechanics in a twofold respect; as rational, which proceeds accurately by demonstration; and practical. To practical mechanics all the manual arts belong, from which mechanics took its name. But as artificers do not work with perfect accuracy, it comes to pass that mechanics is so distinguished from geometry, that what is perfectly accurate is called geometrical; what is less so, is called mechanical. But the errors are not in the art, but in the artificers. He that works with less accuracy is an imperfect mechanic; and if any could work with perfect accuracy, he would be the most perfect mechanic of all; for the description of right lines and circles, upon which geometry is founded, belongs to mechanics. Geometry does not teach us to draw these lines, but requires them to be drawn; for it requires that the learner should first be taught to describe these accurately, before he enters upon geometry; then it shows how by these operations problems may be solved. To describe right lines and circles are problems, but not geometrical problems. The solution of these problems is required from mechanics; and by geometry the use of them, when so solved, is shown; and it is the glory of geometry that from those few principles, brought from without, it is able to produce so many things. Therefore geometry is founded in mechanical practice, and is nothing but that part of universal mechanics which accurately proposes and demonstrates the art of measuring. But since the manual arts are chiefly conversant in the moving of bodies, it comes to pass that geometry is commonly referred to their magnitudes, and mechanics to their motion. In this sense rational mechanics will be the science of motions resulting from any forces whatsoever, and of the forces required to produce any motions, accurately proposed and demonstrated. This part of mechanics was cultivated by the ancients in the five powers which relate to manual arts, who considered gravity (it not being a manual power, no otherwise than as it moved weights by those powers. Our design not respecting arts, but philosophy, and our subject not manual but natural powers, we consider chiefly those things which relate to gravity, levity, elastic force, the resistance of fluids, and the like forces, whether attractive or impulsive; and therefore we offer this work as the mathematical principles of philosophy; for all the difficulty of philosophy seems to consist in this –

from the phænomena of motions to investigate the forces of nature, and then from these forces to demonstrate the other phænomena; and to this end the general propositions in the first and second book are directed. In the third book we give an example of this in the explication of the System of the World; for by the propositions mathematically demonstrated in the former books, we in the third derive from the celestial phænomena the forces of gravity with which bodies tend to the sun and the several planets. Then from these forces, by other propositions which are also mathematical, we deduce the motions of the planets, the comets, the moon, and the sea. I wish we could derive the rest of the phænomena of nature by the same kind of reasoning from mechanical principles; for I am induced by many reasons to suspect that they may all depend upon certain forces by which the particles of bodies, by some causes hitherto unknown, are either mutually impelled towards each other, and cohere in regular figures, or are repelled and recede from each other; which forces being unknown, philosophers have hitherto attempted the search of nature in vain; but I hope the principles here laid down will afford some light either to this or some truer method of philosophy.

In the publication of this work the most acute and universally learned Mr. Edmund Halley not only assisted me with his pains in correcting the press and taking care of the schemes, but it was to his solicitations that its becoming public is owing; for when he had obtained of me my demonstrations of the figure of the celestia1 orbits, he continually pressed me to communicate the same to the Roya1 Society, who afterwards, by their kind encouragement and entreaties, engaged me to think of publishing them. But after I had begun to consider the inequalities of the lunar motions, and had entered upon some other things relating to the laws and measures of gravity, and other forces; and the figures that would be described by bodies attracted according to given laws; and the motion of several bodies moving among themselves; the motion of bodies in resisting mediums; the forces, densities, and motions, of mediums; the orbits of the comets, and such like; deferred that publication till I had made a search into those matters, and could put forth the whole together. What relates to the lunar motions (being imperfect), I have put all together in the corollaries of Prop. 66, to avoid being obliged to propose and distinctly demonstrate the several things there contained in a method more prolix than the subject deserved, and interrupt the series of the several propositions. Some things, found out after the rest, I chose to insert in places less suitable, rather than change the number of the propositions and the citations. I heartily beg that what I have here done may be read with candour; and that the defects in a

subject so difficult be not so much reprehended as kindly supplied, and investigated by new endeavours of my readers.

ISAAC NEWTON.

Cambridge, Trinity College May 8, 1686.

DEFINITIONS.

DEFINITION I.

The quantity of matter is the measure of the same, arising from its density and bulk conjunctly.

THUS air of double density, in a double space, is quadruple in quantity; in a triple space, sextuple in quantity. The same thing is to be understood of snow, and fine dust or powders, that are condensed by compression or liquefaction; and of all bodies that are by any caused whatever differently condensed. I have no regard in this place to a medium, if any such there is, that freely pervades the interstices between the parts of bodies. It is this quantity that I mean hereafter everywhere under the name of body or mass. And the same is known by the weight of each body; for it is proportional to the weight, as I have found by experiments on pendulums, very accurately made, which shall be shewn hereafter.

DEFINITION II.

The quantity of motion is the measure of the same, arising from the velocity and quantity of matter conjunctly.

The motion of the whole is the sum of the motions of all the parts; and therefore in a body double in quantity, with equal velocity, the motion is double; with twice the velocity, it is quadruple.

DEFINITION III.

The vis insita, or innate force of matter, is a power of resisting, by which every body, as much as in it lies, endeavours to persevere in its present state, whether it be of rest, or of moving uniformly forward in a right line.

This force is ever proportional to the body whose force it is; and differs nothing from the inactivity of the mass, but in our manner of conceiving it. A body, from the inactivity of matter, is not without difficulty put out of its state of rest or motion. Upon which account, this vis insita, may, by a most significant name, be called vis inertiæ, or force of inactivity. But a body exerts this force only, when another force, impressed upon it, endeavours to change its condition; and the exercise of this force may be considered both as resistance and impulse; it is resistance, in so far as the

body, for maintaining its present state, withstands the force impressed; it is impulse, in so far as the body, by not easily giving way to the impressed force of another, endeavours to change the state of that other. Resistance is usually ascribed to bodies at rest, and impulse to those in motion; but motion and rest, as commonly conceived, are only relatively distinguished; nor are those bodies always truly at rest, which commonly are taken to be so.

DEFINITION IV.

An impressed force is an action exerted upon a body, in order to change its state, either of rest, or of moving uniformly forward in a right line.

This force consists in the action only; and remains no longer in the body when the action is over. For a body maintains every new state it acquires, by its vis inertiæ only. Impressed forces are of different origins as from percussion, from pressure, from centripetal force.

DEFINITION V.

A centripetal force is that by which bodies are drawn or impelled, or any way tend, towards a point as a centre.

Of this sort is gravity, by which bodies tend to the centre of the earth; magnetism, by which iron tends to the load-stone; and that force, whatever it is, by which the planets are perpetually drawn aside from the rectilinear motions, which otherwise they would pursue, and made to revolve in curvilinear orbits. A stone whirled about in a sling, endeavours to recede from the hand that turns it; and by that endeavour, distends the sling, and that with so much the greater force, as it is revolved with the greater velocity, and as soon as ever it is let go, flies away. That force which opposes itself to this endeavour, and by which the sling perpetually draws back the stone towards the hand, and retains it in its orbit, because it is directed to the hand as the centre of the orbit, I call the centripetal force. And the thing is to be understood of all bodies, revolved in any orbits. They all endeavour to recede from the centres of their orbits; and were it not for the opposition of a contrary force which restrains them to, and detains them in their orbits, which I therefore call centripetal, would fly off in right lines, with a uniform motion. A projectile, if it was not for the force of gravity, would not deviate towards the earth, but would go off from it in a right line, and that with an uniform motion, if the resistance of the air was taken away. It is by its gravity that it is drawn aside perpetually from its rectilinear course, and made to deviate towards the earth more or less, according to the force of its gravity, and the velocity of its motion. The less its gravity is, for the quantity of its matter, or the greater the velocity with which it is projected, the less will it

deviate from a rectilinear course, and the farther it will go. If a leaden ball, projected from the top of a mountain by the force of gunpowder with a given velocity, and in a direction parallel to the horizon, is carried in a curve line to the distance of two miles before it falls to the ground; the same, if the resistance of the air were taken away, with a double or decuple velocity, would fly twice or ten times as far. And by increasing the velocity, we may at pleasure increase the distance to which it might be projected, and diminish the curvature of the line, which it might describe, till at last it should fall at the distance of 10, 30, or 90 degrees, or even might go quite round the whole earth before it falls; or lastly, so that it might never fall to the earth, but go forward into the celestial spaces, and proceed in its motion in infinitum. And after the same manner that a projectile, by the force of gravity, may be made to revolve in an orbit, and go round the whole earth, the moon also, either by the force of gravity, if it is endued with gravity, or by any other force, that impels it towards the earth, may be perpetually drawn aside towards the earth, out of the rectilinear way, which by its innate force it would pursue; and would be made to revolve in the orbit which it now describes; nor could the moon without some such force, be retained in its orbit. If this force was too small, it would not sufficiently turn the moon out of a rectilinear course: if it was too great, it would turn it too much, and draw down the moon from its orbit towards the earth. It is necessary, that the force be of a just quantity, and it belongs to the mathematicians to find the force, that may serve exactly to retain a body in a given orbit, with a given velocity; and vice versa, to determine the curvilinear way, into which a body projected from a given place, with a given velocity, may be made to deviate from its natural rectilinear way, by means of a given force.

The quantity of any centripetal force may be considered as of three kinds; absolute, accelerative, and motive.

DEFINITION VI.

The absolute quantity of a centripetal force is the measure of the same proportional to the efficacy of the cause that propagates it from the centre, through the spaces round about.

Thus the magnetic force is greater in one load-stone and less in another according to their sizes and strength of intensity.

DEFINITION VII.

The accelerative quantity of a centripetal force is the measure of the same, proportional to the velocity which it generates in a given time.

Thus the force of the same load-stone is greater at a less distance, and less at a greater: also the force of gravity is greater in valleys, less on tops

of exceeding high mountains; and yet less (as shall hereafter be shown), at greater distances from the body of the earth; but at equal distances, it is the same everywhere; because (taking away, or allowing for the resistance of the air), it equally accelerates all falling bodies, whether heavy or light, great or small.

DEFINITION VIII.

The motive quantity of a centripetal force, is the measure of the same, proportional to the motion which it generates in a given time.

Thus the weight is greater in a greater body, less in a less body; and, in the same body, it is greater near to the earth, and less at remoter distances. This sort of quantity is the centripetency, or propension of the whole body towards the centre, or, as I may say, its weight; and it is always known by the quantity of an equal and contrary force just sufficient to hinder, the descent of the body.

These quantities of forces, we may, for brevity's sake, call by the names of motive, accelerative, and absolute forces; and, for distinction's sake, consider them, with respect to the bodies that tend to the centre; to the places of those bodies; and to the centre of force towards which they tend; that is to say, I refer the motive force to the body as an endeavour and propensity of the whole towards a centre, arising from the propensities of the several parts taken together; the accelerative force to the place of the body, as a certain power or energy diffused from the centre to all places around to move the bodies that are in them; and the absolute force to the centre, as endued with some cause, without which those motive forces would not be propagated through the spaces round about; whether that cause be some central body (such as is the load-stone, in the centre of the magnetic force, or the earth in the centre of the gravitating force), or anything else that does not yet appear. For I here design only to give a mathematical notion of those forces, without considering their physical causes and seats.

Wherefore the accelerative force will stand in the same relation to the motive, as celerity does to motion. For the quantity of motion arises from the celerity drawn into the quantity of matter; and the motive force arises from the accelerative force drawn into the same quantity of matter. For the sum of the actions of the accelerative force, upon the several particles of the body, is the motive force of the whole. Hence it is, that near the surface of the earth, where the accelerative gravity, or force productive of gravity, in all bodies is the same, the motive gravity or the weight is as the body: but if we should ascend to higher regions, where the accelerative gravity is less, the weight would be equally diminished, and would always be as the product of the body, by the accelerative gravity. So in those

regions, where the accelerative gravity is diminished into one half, the weight of a body two or three times less, will be four or six times less.
I likewise call attractions and impulses, in the same sense, accelerative, and motive; and use the words attraction, impulse or propensity of any sort towards a centre, promiscuously, and indifferently, one for another; considering those forces not physically, but mathematically: wherefore, the reader is not to imagine, that by those words, I anywhere take upon me to define the kind, or the manner of any action, the causes or the physical reason thereof, or that I attribute forces, in a true and physical sense, to certain centres (which are only mathematical points); when at any time I happen to speak of centres as attracting, or as endued with attractive powers.

SCHOLIUM.

Hitherto I have laid down the definitions of such words as are less known, and explained the sense in which I would have them to be understood in the following discourse. I do not define time, space, place and motion, as being well known to all. Only I must observe, that the vulgar conceive those quantities under no other notions but from the relation they bear to sensible objects. And thence arise certain prejudices, for the removing of which, it will be convenient to distinguish them into absolute and relative, true and apparent, mathematical and common.

I. Absolute, true, and mathematical time, of itself, and from its own nature flows equably without regard to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external (whether accurate or unequable) measure of duration by the means of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year.

II. Absolute space, in its own nature, without regard to anything external, remains always similar and immovable. Relative space is some movable dimension or measure of the absolute spaces; which our senses determine by its position to bodies; and which is vulgarly taken for immovable space; such is the dimension of a subterraneaneous, an æreal, or celestial space, determined by its position in respect of the earth. Absolute and relative space, are the same in figure and magnitude; but they do not remain always numerically the same. For if the earth, for instance, moves, a space of our air, which relatively and in respect of the earth remains always the same, will at one time be one part of the

absolute space into which the air passes; at another time it will be another part of the same, and so, absolutely understood, it will be perpetually mutable.

III. Place is a part of space which a body takes up, and is according to the space, either absolute or relative. I say, a part of space; not the situation nor the external surface of the body. For the places of equal solids are always equal; but their superfices, by reason of their dissimilar figures, are often unequal. Positions properly have no quantity, nor are they so much the places themselves, as the properties of places. The motion of the whole is the same thing with the sum of the motions of the parts; that is, the translation of the whole, out of its place, is the same thing with the sum of the translations of the parts out of their places; and therefore the place of the whole is the same thing with the sum of the places of the parts, and for that reason, it is internal, and in the whole body.

IV. Absolute motion is the translation of a body from one absolute place into another; and relative motion, the translation from one relative place into another. Thus in a ship under sail, the relative place of a body is that part of the ship which the body possesses; or that part of its cavity which the body fills, and which therefore moves together with the ship: and relative rest is the continuance of the body in the same part of the ship, or of its cavity. But real, absolute rest, is the continuance of the body in the same part of that immovable space, in which the ship itself, its cavity, and all that it contains, is moved. Wherefore if the earth is really at rest, the body, which relatively rests in the ship, will really and absolutely move with the same velocity which the ship has on the earth. But if the earth also moves, the true and absolute motion of the body will arise, partly from the true motion of the earth, in immovable space; partly from the relative motion of the ship on the earth; and if the body moves also relatively in the ship; its true motion will arise, partly from the true motion of the earth, in immovable space, and partly from the relative motions as well of the ship on the earth, as of the body in the ship; and from these relative motions will arise the relative motion of the body on the earth. As if that part of the earth, where the ship is, was truly moved toward the east, with a velocity of 10010 parts; while the ship itself, with fresh gale, and full sails, is carried towards the west, with a velocity expressed by 10 of those parts; but a sailor walks in the ship towards the east, with 1 part of the said velocity; then the sailor will be moved truly in immovable space towards the east, with a velocity of 10001 parts, and relatively on the earth towards the west, with a velocity of 9 of those parts.

Absolute time, in astronomy, is distinguished from relative, by the equation or correlation of the vulgar time. For the natural days are truly unequal, though they are commonly considered as equal and used for a measure of time; astronomers correct this inequality for their more accurate deducing of the celestial motions. It may be, that there is no such thing as an equable motion, whereby time may be accurately measured. All motions may be accelerated and retarded, but the true, or equable, progress of absolute time is liable to no change. The duration or perseverance of the existence of things remains the same, whether the motions are swift or slow, or none at all: and therefore, it ought to be distinguished from what are only sensible measures thereof; and out of which we collect it, by means of the astronomical equation. The necessity of which equation, for determining the times of a phænomenon, is evinced as well from the experiments of the pendulum clock, as by eclipses of the satellites of Jupiter.

As the order of the parts of time is immutable, so also is the order of the parts of space. Suppose those parts to be moved out of their places, and they will be moved (if the expression may be allowed) out of themselves. For times and spaces are, as it were, the places as well of themselves as of all other things. All things are placed in time as to order of succession; and in space as to order of situation. It is from their essence or nature that they are places; and that the primary places of things should be moveable, is absurd. These are therefore the absolute places; and translations out of those places, are the only absolute motions.

But because the parts of space cannot be seen, or distinguished from one another by our senses, therefore in their stead we use sensible measures of them. For from the positions and distances of things from any body considered as immovable, we define all places; and then with respect to such places, we estimate all motions, considering bodies as transferred from some of those places into others. And so, instead of absolute places and motions, we use relative ones; and that without any inconvenience in common affairs; but in philosophical disquisitions, we ought to abstract from our senses, and consider things themselves, distinct from what are only sensible measures of them. For it may be that there is no body really at rest, to which the places and motions of others may be referred.

But we my distinguish rest and motion, absolute and relative, one from the other by their properties, causes and effects. It is a property of rest, that bodies really at rest do rest in respect to one another. And therefore as it is possible, that in the remote regions of the fixed stars, or perhaps far beyond them, there may be some body absolutely at rest; but impossible to know, from the position of bodies to one another in our

regions whether any of these do keep the same position to that remote body; it follows that absolute rest cannot be determined from the position of bodies in our regions.

It is a property of motion, that the parts, which retain given positions to their wholes, do partake of the motions of those wholes. For all the parts of revolving bodies endeavour to recede from the axis of motion; and the impetus of bodies moving forward, arises from the joint impetus of all the parts. Therefore, if surrounding bodies are moved, those that are relatively at rest within them, will partake of their motion. Upon which account, the true and absolute motion of a body cannot be determined by the translation of it from those which only seem to rest; for the external bodies ought not only to appear at rest, but to be really at rest. For otherwise, all included bodies, beside their translation from near the surrounding ones, partake likewise of their true motions; and though that translation were not made they would not be really at rest, but only seem to be so. For the surrounding bodies stand in the like relation to the surrounded as the exterior part of a whole does to the interior, or as the shell does to the kernel; but, if the shell moves, the kernel will also move, as being part of the whole, without any removal from near the shell.

A property, near akin to the preceding, is this, that if a place is moved, whatever is placed therein moves along with it; and therefore a body, which is moved from a place in motion, partakes also of the motion of its place. Upon which account, all motions, from places in motion, are no other than parts of entire and absolute motions; and every entire motion is composed of the motion of the body out of its first place, and the motion of this place out of its place; and so on, until we come to some immovable place, as in the before-mentioned example of the sailor. Wherefore, entire and absolute motions can be no otherwise determined than by immovable places; and for that reason I did before refer those absolute motions to immovable places, but relative ones to movable places. Now no other places are immovable but those that, from infinity to infinity, do all retain the same given position to one another; and upon this account must ever remain unmoved; and do thereby constitute immovable space.

The causes by which true, and relative motions are distinguished, one from the other, are the forces impressed upon bodies to generate motion. True motion is neither generated nor altered, but by some force impressed upon the body moved; but relative motion may be generated or altered without any force impressed upon the body. For it is sufficient only to impress some force on other bodies with which the former is compared, that by their giving way, that relation may be changed, in which the relative rest or motion of this other body did consist. Again,

true motion suffers always some change from any force impressed upon, the moving body; but relative motion does not necessarily undergo any change by such forces. For if the same forces are likewise impressed on those other bodies, with which the comparison is made, that the relative position may be preserved, then that condition will be preserved in which the relative motion consists. And therefore any relative motion may be changed when the true motion remains unaltered, and the relative may be preserved when the true suffers some change. Upon which accounts, true motion does by no means consist in such relations.

The effects which distinguish absolute from relative motion are, the forces of receding from the axis of circular motion. For there are no such forces in a circular motion purely relative, but in a true and absolute circular motion, they are greater or less, according to the quantity of the motion. If a vessel, hung by a long cord, is so often turned about that the cord is strongly twisted, then filled with water, and held at rest together with the water; after, by the sudden action of another force, it is whirled about the contrary way, and while the cord is untwisting itself, the vessel continues, for some time in this motion; the surface of the water will at first be plain, as before the vessel began to move: but the vessel, by gradually communicating its motion to the water, will make it begin sensibly to evolve, and recede by little and little from the middle, and ascend to the sides of the vessel, forming itself into a concave figure (as I have experienced), and the swifter the motion becomes, the higher will the water rise, till at last, performing its revolutions in the same times with the vessel, it becomes relatively at rest in it. This ascent of the water shows its endeavour to recede from the axis of its motion; and the true and absolute circular motion of the water, which is here directly contrary to the relative, discovers itself, and may be measured by this endeavour. At first, when the relative motion of the water in the vessel was greatest, it produced no endeavour to recede from the axis; the water showed no tendency to the circumference, nor any ascent towards the sides of the vessel, but remained of a plain surface, and therefore its true circular motion had not yet begun. But afterwards, when the relative motion of the water had decreased, the ascent thereof towards the sides of the vessel proved its endeavour to recede from the axis; and this endeavour showed the real circular motion of the water perpetually increasing, till it had acquired its greatest quantity, when the water rested relatively in the vessel. And therefore this endeavour, does not depend upon any translation of the water in respect of the ambient bodies, nor can true circular motion be defined by such translation. There is only one real circular motion of any one revolving body, corresponding to only one power of endeavouring to recede from its axis of motion, as its proper

and adequate effect; but relative motions, in one and the same body, are innumerable, according to the various relations it bears to external bodies, and like other relations, are altogether destitute of any real effect, any otherwise than they may partake of that one only true motion. And therefore in their system who suppose that our heavens, revolving below the sphere of the fixed stars, carry the planets along with them; the several parts of those heavens and the planets, which are indeed relatively at rest in their heavens, do yet really move. For they change their position one to another (which never happens to bodies truly at rest), and being carried together with their heavens, partake of their motions, and as parts of revolving wholes, endeavour to recede from the axis of their motions.

Wherefore relative quantities are not the quantities themselves, whose names they bear, but those sensible measures of them (either accurate or inaccurate), which are commonly used instead of the measured quantities themselves. And if the meaning of words is to be determined by their use, then by the names time, space, place and motion, their measures are properly to be understood; and the expression will be unusual, and purely mathematical, if the measured quantities themselves are meant. Upon which account, they do strain the sacred writings, who there interpret those words for the measured quantities. Nor do those less defile the purity of mathematical and philosophical truths, who confound real quantities themselves with their relations and vulgar measures.

It is indeed a matter of great difficulty to discover, and effectually to distinguish, the true motion of particular bodies from the apparent; because the parts of that immovable space, in which those motions are performed, do by no means come under the observation of our senses. Yet the thing is not altogether desperate; for we have some arguments to guide us, partly from the apparent motions, which are the differences of the true motions; partly from the forces, which are the causes and effects of the true motion. For instance, if two globes, kept at a given distance one from the other by means of a cord that connects them, were revolved about their common centre of gravity, we might, from the tension of the cord, discover the endeavour of the globes to recede from the axis of their motion, and from thence we might compute the quantity of their circular motions. And then if any equal forces should be impressed at once on the alternate faces of the globes to augment or diminish their circular motions, from the increase or decrease of the tension of the cord, we might infer the increment or decrement of their motions; and thence would be found on what faces those forces ought to be impressed, that the motions of the globes might be most augmented; that is, we might

discover their hindermost faces, or those which, in the circular motion, do follow. But the faces which follow being known and consequently the opposite ones that precede, we should likewise know the determination of their motions. And thus we might find both the quantity and the determination of this circular motion, even in an immense vacuum, where there was nothing external or sensible with which the globes could be compared. But now, if in that space some remote bodies were placed the kept always a given position one to another, as the fixed stars do in our regions, we could not indeed determine from the relative translation of the globes among those bodies, whether the motion did belong to the globes or to the bodies. But if we observed the cord, and found that its tension was that very tension which the motions f the globes required, we might conclude the motion to be in the globes, and the bodies to be at rest; and then, lastly, from the translation of the globes among the bodies, we should find the determination of their motions. But how we are to collect the true motions from their causes, effects, and apparent differences; and, vice versa, how from the motions, either true or apparent, we may come to the knowledge of their causes and effects, shall be explained more at large in the following tract. For to this end it was that I composed it.

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From *Origin of Species*
Darwin

CHAPTER III.
STRUGGLE FOR EXISTENCE.

Its bearing on natural selection—The term used in a wide sense—Geometrical ratio of increase—Rapid increase of naturalised animals and plants—Nature of the checks to increase—Competition universal—Effects of climate—Protection from the number of individuals—Complex relations of all animals and plants throughout nature—Struggle for life most severe between individuals and varieties of the same species: often severe between species of the same genus—The relation of organism to organism the most important of all relations.

BEFORE entering on the subject of this chapter, I must make a few preliminary remarks, to show how the struggle for existence bears on Natural Selection. It has been seen in the last chapter that amongst organic beings in a state of nature there is some individual variability: indeed I am not aware that this has ever been disputed. It is immaterial for us whether a multitude of doubtful forms be called species or sub-species or varieties; what rank, for instance, the two or three hundred doubtful forms of British plants are entitled to hold, if the existence of any well-marked varieties be admitted. But the mere existence of individual variability and of some few well-marked varieties, though necessary as the foundation for the work, helps us but little in understanding how species arise in nature. How have all those exquisite adaptations of one part of the organisation to another part, and to the conditions of life, and of one organic being to another being, been perfected? We see these beautiful co-adaptations most plainly in the woodpecker and the misletoe; and only a little less plainly in the humblest parasite which clings to the hairs of a quadruped or feathers of a bird; in the structure of the beetle which dives through the water: in the plumed seed which is wafted by the gentlest breeze; in short, we see beautiful adaptations everywhere and in every part of the organic world.

Again, it may be asked, how is it that varieties, which I have called incipient species, become ultimately converted into good and distinct species, which in most cases obviously differ from each other far more than do the varieties of the same species? How do those groups of species, which constitute what are called distinct genera, and which differ from each other more than do the species of the same genus, arise? All these results, as we shall more fully see in the next chapter, follow from the struggle for life. Owing to this struggle, variations, however slight, and from whatever cause proceeding, if they be in any degree profitable to

the individuals of a species, in their infinitely complex relations to other organic beings and to their physical conditions of life, will tend to the preservation of such individuals, and will generally be inherited by the offspring. The offspring, also, will thus have a better chance of surviving, for, of the many individuals of any species which are periodically born, but a small number can survive. I have called this principle, by which each slight variation, if useful, is preserved, by the term Natural Selection, in order to mark its relation to man's power of selection. But the expression often used by Mr. Herbert Spencer of the Survival of the Fittest is more accurate, and is sometimes equally convenient. We have seen that man by selection can certainly produce great results, and can adapt organic beings to his own uses, through the accumulation of slight but useful variations, given to him by the hand of Nature. But Natural Selection, as we shall hereafter see, is a power incessantly ready for action, and is as immeasurably superior to man's feeble efforts, as the works of Nature are to those of Art.

We will now discuss in a little more detail the struggle for existence. In my future work this subject will be treated, as it well deserves, at greater length. The elder De Candolle and Lyell have largely and philosophically shown that all organic beings are exposed to severe competition. In regard to plants, no one has treated this subject with more spirit and ability than W. Herbert, Dean of Manchester, evidently the result of his great horticultural knowledge. Nothing is easier than to admit in words the truth of the universal struggle for life, or more difficult—at least I have found it so—than constantly to bear this conclusion in mind. Yet unless it be thoroughly engrained in the mind, the whole economy of nature, with every fact on distribution, rarity, abundance, extinction, and variation, will be dimly seen or quite misunderstood. We behold the face of nature bright with gladness, we often see superabundance of food; we do not see or we forget, that the birds which are idly singing round us mostly live on insects or seeds, and are thus constantly destroying life; or we forget how largely these songsters, or their eggs, or their nestlings, are destroyed by birds and beasts of prey; we do not always bear in mind, that, though food may be now superabundant, it is not so at all seasons of each recurring year.

The Term, Struggle for Existence, used in a large sense.

I should premise that I use this term in a large and metaphorical sense including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny. Two canine animals, in a time of dearth, may be truly said to struggle with each other which shall get food and live. But a plant

on the edge of a desert is said to struggle for life against the drought, though more properly it should be said to be dependent on the moisture. A plant which annually produces a thousand seeds, of which only one on an average comes to maturity, may be more truly said to struggle with the plants of the same and other kinds which already clothe the ground. The misletoe is dependent on the apple and a few other trees, but can only in a far-fetched sense be said to struggle with these trees, for, if too many of these parasites grow on the same tree, it languishes and dies. But several seedling misletoes, growing close together on the same branch, may more truly be said to struggle with each other. As the misletoe is disseminated by birds, its existence depends on them; and it may metaphorically be said to struggle with other fruit-bearing plants, in tempting the birds to devour and thus disseminate its seeds. In these several senses, which pass into each other, I use for convenience' sake the general term of Struggle for Existence.

Geometrical Ratio of Increase.

A struggle for existence inevitably follows from the high rate at which all organic beings tend to increase. Every being, which during its natural lifetime produces several eggs or seeds, must suffer destruction during some period of its life, and during some season or occasional year, otherwise, on the principle of geometrical increase, its numbers would quickly become so inordinately great that no country could support the product. Hence, as more individuals are produced than can possibly survive, there must in every case be a struggle for existence, either one individual with another of the same species, or with the individuals of distinct species, or with the physical conditions of life. It is the doctrine of Malthus applied with manifold force to the whole animal and vegetable kingdoms; for in this case there can be no artificial increase of food, and no prudential restraint from marriage. Although some species may be now increasing, more or less rapidly, in numbers, all cannot do so, for the world would not hold them.

There is no exception to the rule that every organic being naturally increases at so high a rate, that, if not destroyed, the earth would soon be covered by the progeny of a single pair. Even slow-breeding man has doubled in twenty-five years, and at this rate, in less than a thousand years, there would literally not be standing-room for his progeny. Linnæus has calculated that if an annual plant produced only two seeds—and there is no plant so unproductive as this—and their seedlings next year produced two, and so on, then in twenty years there would be a million plants. The elephant is reckoned the slowest breeder of all known animals, and I have taken some pains to estimate its

probable minimum rate of natural increase; it will be safest to assume that it begins breeding when thirty years old, and goes on breeding till ninety years old, bringing forth six young in the interval, and surviving till one hundred years old; if this be so, after a period of from 740 to 750 years there would be nearly nineteen million elephants alive, descended from the first pair.

But we have better evidence on this subject than mere theoretical calculations, namely, the numerous recorded cases of the astonishingly rapid increase of various animals in a state of nature, when circumstances have been favourable to them during two or three following seasons. Still more striking is the evidence from our domestic animals of many kinds which have run wild in several parts of the world; if the statements of the rate of increase of slow-breeding cattle and horses in South America, and latterly in Australia, had not been well authenticated, they would have been incredible. So it is with plants; cases could be given of introduced plants which have become common throughout whole islands in a period of less than ten years. Several of the plants, such as the cardoon and a tall thistle, which are now the commonest over the wide plains of La Plata, clothing square leagues of surface almost to the exclusion of every other plant, have been introduced from Europe; and there are plants which now range in India, as I hear from Dr. Falconer, from Cape Comorin to the Himalaya, which have been imported from America since its discovery. In such cases, and endless others could be given, no one supposes, that the fertility of the animals or plants has been suddenly and temporarily increased in any sensible degree. The obvious explanation is that the conditions of life have been highly favourable, and that there has consequently been less destruction of the old and young, and that nearly all the young have been enabled to breed. Their geometrical ratio of increase, the result of which never fails to be surprising, simply explains their extraordinarily rapid increase and wide diffusion in their new homes.

In a state of nature almost every full-grown plant annually produces seed, and amongst animals there are very few which do not annually pair. Hence we may confidently assert, that all plants and animals are tending to increase at a geometrical ratio,—that all would rapidly stock every station in which they could any how exist,—and that this geometrical tendency to increase must be checked by destruction at some period of life. Our familiarity with the larger domestic animals tends, I think, to mislead us: we see no great destruction falling on them, but we do not keep in mind that thousands are annually slaughtered for food, and that in a state of nature an equal number would have somehow to be disposed of.

The only difference between organisms which annually produce eggs or seeds by the thousand, and those which produce extremely few, is, that the slow-breeders would require a few more years to people, under favourable conditions, a whole district, let it be ever so large. The condor lays a couple of eggs and the ostrich a score, and yet in the same country the condor may be the more numerous of the two; the Fulmar petrel lays but one egg, yet it is believed to be the most numerous bird in the world. One fly deposits hundreds of eggs, and another, like the hippobosca, a single one; but this difference does not determine how many individuals of the two species can be supported in a district. A large number of eggs is of some importance to those species which depend on a fluctuating amount of food, for it allows them rapidly to increase in number. But the real importance of a large number of eggs or seeds is to make up for much destruction at some period of life; and this period in the great majority of cases is an early one. If an animal can in any way protect its own eggs or young, a small number may be produced, and yet the average stock be fully kept up; but if many eggs or young are destroyed, many must be produced, or the species will become extinct. It would suffice to keep up the full number of a tree, which lived on an average for a thousand years, if a single seed were produced once in a thousand years, supposing that this seed were never destroyed, and could be ensured to germinate in a fitting place. So that, in all cases, the average number of any animal or plant depends only indirectly on the number of its eggs or seeds.

In looking at Nature, it is most necessary to keep the foregoing considerations always in mind—never to forget that every single organic being may be said to be striving to the utmost to increase in numbers; that each lives by a struggle at some period of its life; that heavy destruction inevitably falls either on the young or old, during each generation or at recurrent intervals. Lighten any check, mitigate the destruction ever so little, and the number of the species will almost instantaneously increase to any amount.

Nature of the Checks to Increase.

The causes which check the natural tendency of each species to increase are most obscure. Look at the most vigorous species; by as much as it swarms in numbers, by so much will it tend to increase still further. We know not exactly what the checks are even in a single instance. Nor will this surprise any one who reflects how ignorant we are on this head, even in regard to mankind, although so incomparably better known than any other animal. This subject of the checks to increase has been ably treated by several authors, and I hope in a future work to discuss it at

considerable length, more especially in regard to the feral animals of South America. Here I will make only a few remarks, just to recall to the reader's mind some of the chief points. Eggs or very young animals seem generally to suffer most, but this is not invariably the case. With plants there is a vast destruction of seeds, but, from some observations which I have made it appears that the seedlings suffer most from germinating in ground already thickly stocked with other plants. Seedlings, also, are destroyed in vast numbers by various enemies; for instance, on a piece of ground three feet long and two wide, dug and cleared, and where there could be no choking from other plants, I marked all the seedlings of our native weeds as they came up, and out of 357 no less than 295, were destroyed, chiefly by slugs and insects. If turf which has long been mown, and the case would be the same with turf closely browsed by quadrupeds, be let to grow, the more vigorous plants gradually kill the less vigorous, though fully grown plants; thus out of twenty species growing on a little plot of mown turf (three feet by four) nine species perished, from the other species being allowed to grow up freely.

The amount of food for each species of course gives the extreme limit to which each can increase; but very frequently it is not the obtaining food, but the serving as prey to other animals, which determines the average numbers of a species. Thus, there seems to be little doubt that the stock of partridges, grouse, and hares on any large estate depends chiefly on the destruction of vermin. If not one head of game were shot during the next twenty years in England, and, at the same time, if no vermin were destroyed, there would, in all probability, be less game than at present, although hundreds of thousands of game animals are now annually shot. On the other hand, in some cases, as with the elephant, none an destroyed by beasts of prey; for even the tiger in India most rarely dares to attack a young elephant protected by its dam.

Climate plays an important part in determining the average numbers of a species, and periodical seasons of extreme cold or drought seem to be the most effective of all checks. I estimated (chiefly from the greatly reduced numbers of nests in the spring) that the winter of 1854-5 destroyed four-fifths of the birds in my own grounds; and this is a tremendous destruction, when we remember that ten per cent, is an extraordinarily severe mortality from epidemics with man. The action of climate seems at first sight to be quite independent of the struggle for existence; but in so far as climate chiefly acts in reducing food, it brings on the most severe struggle between the individuals, whether of the same or of distinct species, which subsist on the same kind of food. Even when climate, for instance extreme cold, acts directly, it will be the least vigorous individuals, or those which have got least food through the

advancing winter, which will suffer most. When we travel from south to north, or from a damp region to a dry, we invariably see some species gradually getting rarer and rarer, and finally disappearing; and the change of climate being conspicuous, we are tempted to attribute the whole effect to its direct action. But this is a false view; we forget that each species, even where it most abounds, is constantly suffering enormous destruction at some period of its life, from enemies or from competitors for the same place and food; and if these enemies or competitors be in the least degree favoured by any slight change of climate, they will increase in numbers; and as each area is already fully stocked with inhabitants, the other species must decrease. When we travel southward and see a species decreasing in numbers, we may feel sure that the cause lies quite as much in other species being favoured, as in this one being hurt. So it is when we travel northward, but in a somewhat lesser degree, for the number of species of all kinds, and therefore of competitors, decreases northwards; hence in going northwards, or in ascending a mountain, we far oftener meet with stunted forms, due to the directly injurious action of climate, than we do in proceeding southwards or in descending a mountain. When we reach the Arctic regions, or snow-capped summits, or absolute deserts, the struggle for life is almost exclusively with the elements.

That climate acts in main part indirectly by favouring other species, we clearly see in the prodigious number of plants which in our gardens can perfectly well endure our climate, but which never become naturalised, for they cannot compete with our native plants nor resist destruction by our native animals.

When a species, owing to highly favourable circumstances, increases inordinately in numbers in a small tract, epidemics—at least, this seems generally to occur with our game animals—often ensue; and here we have a limiting check independent of the struggle for life. But even some of these so-called epidemics appear to be due to parasitic worms, which have from some cause, possibly in part through facility of diffusion amongst the crowded animals, been disproportionally favoured: and here comes in a sort of struggle between the parasite and its prey.

On the other hand, in many cases, a large stock of individuals of the same species, relatively to the numbers of its enemies, is absolutely necessary for its preservation. Thus we can easily raise plenty of corn and rape-seed, &c., in our fields, because the seeds are in great excess compared with the number of birds which feed on them; nor can the birds, though having a superabundance of food at this one season, increase in number proportionally to the supply of seed, as their numbers are checked during winter; but any one who has tried, knows how

troublesome it is to get seed from a few wheat or other such plants in a garden: I have in this case lost every single seed. This view of the necessity of a large stock of the same species for its preservation, explains, I believe some singular facts in nature such as that of very rare plants being sometimes extremely abundant, in the few spots where they do exist; and that of some social plants being social, that is abounding in individuals, even on the extreme verge of their range. For in such cases, we may believe, that a plant could exist only where the conditions of its life were so favourable that many could exist together, and thus save the species from utter destruction. I should add that the good effects of intercrossing, and the ill effects of close interbreeding, no doubt come into play in many of these cases; but I will not here enlarge on this subject.

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Struggle for Life most severe between Individuals and Varieties of the same Species.

As the species of the same genus usually have, though by no means invariably, much similarity in habits and constitution, and always in structure, the struggle will generally be more severe between them, if they come into competition with each other, than between the species of distinct genera. We see this in the recent extension over parts of the United States of one species of swallow having caused the decrease of another species. The recent increase of the missel-thrush in parts of Scotland has caused the decrease of the song-thrush. How frequently we hear of one species of rat taking the place of another species under the most different climates! In Russia the small Asiatic cockroach has everywhere driven before it its great congener. In Australia the imported hive-bee is rapidly exterminating the small, stingless native bee. One species of charlock has been known to supplant another species; and so in other cases. We can dimly see why the competition should be most severe between allied forms, which fill nearly the same place in the economy of nature; but probably in no one case could we precisely say why one species has been victorious over another in the great battle of life.

A corollary of the highest importance may be deduced from the foregoing remarks, namely, that the structure of every organic being is related, in the most essential yet often hidden manner, to that of all the other organic beings, with which it comes into competition for food or residence, or from which it has to escape, or on which it preys. This is obvious in the structure of the teeth and talons of the tiger; and in that of the legs and claws of the parasite which clings to the hair on the tiger's body. But in the beautifully plumed seed of the dandelion, and in the

flattened and fringed legs of the water-beetle, the relation seems at first confined to the elements of air and water. Yet the advantage of plumed seeds no doubt stands in the closest relation to the land being already thickly clothed with other plants; so that the seeds may be widely distributed and fall on unoccupied ground. In the water-beetle, the structure of its legs, so well adapted for diving, allows it to compete with other aquatic insects, to hunt for its own prey, and to escape serving as prey to other animals.

The store of nutriment laid up within the seeds of many plants seems at first sight to have no sort of relation to other plants. But from the strong growth of young plants produced from such seeds, as peas and beans, when sown in the midst of long grass, it may be suspected that the chief use of the nutriment in the seed is to favour the growth of the seedlings, whilst struggling with other plants growing vigorously all around.

Look at a plant in the midst of its range, why does it not double or quadruple its numbers? We know that it can perfectly well withstand a little more heat or cold, dampness or dryness, for elsewhere it ranges into slightly hotter or colder, damper or drier districts. In this case we can clearly see that if we wish in imagination to give the plant the power of increasing in number, we should have to give it some advantage over its competitors, or over the animals which prey on it. On the confines of its geographical range, a change of constitution with respect to climate would clearly be an advantage to our plant; but we have reason to believe that only a few plants or animals range so far, that they are destroyed exclusively by the rigour of the climate. Not until we reach the extreme confines of life, in the Arctic regions or on the borders of an utter desert, will competition cease. The land may be extremely cold or dry, yet there will be competition between some few species, or between the individuals of the same species, for the warmest or dampest spots.

Hence we can see that when a plant or animal is placed in a new country amongst new competitors, the conditions of its life will generally be changed in an essential manner, although the climate may be exactly the same as in its former home. If its average numbers are to increase in its new home, we should have to modify it in a different way to what we should have had to do in its native country; for we should have to give it some advantage over a different set of competitors or enemies.

It is good thus to try in imagination to give to any one species an advantage over another. Probably in no single instance should we know what to do. This ought to convince us of our ignorance on the mutual relations of all organic beings; a conviction as necessary, as it is difficult to acquire. All that we can do, is to keep steadily in mind that each organic

being is striving to increase in a geometrical ratio; that each at some period of its life, during some season of the year, during each generation or at intervals, has to struggle for life and to suffer great destruction. When we reflect on this struggle, we may console ourselves with the full belief, that the war of nature is not incessant, that no fear is felt, that death is generally prompt, and that the vigorous, the healthy, and the happy survive and multiply.

CHAPTER IV.
NATURAL SELECTION; OR THE SURVIVAL OF THE FITTEST.

Natural Selection—its power compared with man's selection—its power on characters of trifling importance—its power at all ages and on both sexes—Sexual Selection—On the generality of intercrosses between individuals of the same species—Circumstances favourable and unfavourable to the results of Natural Selection, namely, intercrossing, isolation, number of individuals—Slow action—Extinction caused by Natural Selection—Divergence of Character, related to the diversity of inhabitants of any small area, and to naturalisation—Action of Natural Selection, through Divergence of Character, and Extinction, on the descendants from a common parent—Explains the grouping of all organic beings—Advance in organisation—Low forms preserved—Convergence of character—Indefinite multiplication of species—Summary.

How will the struggle for existence, briefly discussed in the last chapter, act in regard to variation? Can the principle of selection, which we have seen is so potent in the hands of man, apply under nature? I think we shall see that it can act most efficiently. Let the endless number of slight variations and individual differences occurring in our domestic productions, and, in a lesser degree, in those under nature, be borne in mind; as well as the strength of the hereditary tendency. Under domestication, it may be truly said that the whole organisation becomes in some degree plastic. But the variability, which we almost universally meet with in our domestic productions, is not directly produced, as Hooker and Asa Gray have well remarked, by man; he can neither originate varieties, nor prevent their occurrence; he can only preserve and accumulate such as do occur. Unintentionally he exposes organic beings to new and changing conditions of life, and variability ensues; but similar changes of conditions of life, and variability ensues; but similar changes of conditions might and do occur under nature. Let it also be borne in mind how infinitely complex and close-fitting are the mutual relations of all organic beings to each other and to their physical conditions of life; and consequently what infinitely varied diversities of structure might be of use to each being under changing conditions of life. Can it, then, be thought improbable, seeing that variations useful to man have undoubtedly

occurred, that other variations useful in some way to each being in the great and complex battle of life, should occur in the course of many successive generations? If such do occur, can we doubt (remembering that many more individuals are born than can possibly survive) that individuals having any advantage, however slight, over others, would have the best chance of surviving and of procreating their kind? On the other hand, we may feel sure that any variation in the least degree injurious would be rigidly destroyed. This preservation of favourable individual differences and variations, and the destruction of those which are injurious, I have called Natural Selection, or the Survival of the Fittest. Variations neither useful nor injurious would not be affected by natural selection, and would be left either a fluctuating element, as perhaps we see in certain polymorphic species, or would ultimately become fixed, owing to the nature of the organism and the nature of the conditions.

Several writers have misapprehended or objected to the term Natural Selection. Some have even imagined that natural selection induces variability, whereas it implies only the preservation of such variations as arise and are beneficial to the being under its conditions of life. No one objects to agriculturists speaking of the potent effects of man's selection; and in this case the individual differences given by nature, which man for some object selects, must of necessity first occur. Others have objected that the term selection implies conscious choice in the animals which become modified; and it has even been urged that, as plants have no volition, natural selection is not applicable to them! In the literal sense of the word, no doubt, natural selection is a false term; but who ever objected to chemists speaking of the elective affinities of the various elements?—and yet an acid cannot strictly be said to elect the base with which it in preference combines. It has been said that I speak of natural selection as an active power or Deity; but who objects to an author speaking of the attraction of gravity as ruling the movements of the planets? Every one knows what is meant and is implied by such metaphorical expressions; and they are almost necessary for brevity. So again it is difficult to avoid personifying the word Nature; but I mean by Nature, only the aggregate action and product of many natural laws, and by laws the sequence of events as ascertained by us. With a little familiarity such superficial objections will be forgotten.

We shall best understand the probable course of natural selection by taking the case of a country undergoing some slight physical change, for instance, of climate. The proportional numbers of its inhabitants will almost immediately undergo a change, and some species will probably become extinct. We may conclude, from what we have seen of the intimate and complex manner in which the inhabitants of each

country are bound together, that any change in the numerical proportions of the inhabitants, independently of the change of climate itself, would seriously affect the others. If the country were open on its borders, new forms would certainly immigrate, and this would likewise seriously disturb the relations of some of the former inhabitants. Let it be remembered how powerful the influence of a single introduced tree or mammal has been shown to be. But in the case of an island, or of a country partly surrounded by barriers, into which new and better adapted forms could not freely enter, we should then have places in the economy of nature which would assuredly be better filled up, if some of the original inhabitants were in some manner modified; for, had the area been open to immigration, these same places would have been seized on by intruders. In such cases, slight modifications, which in any way favoured the individuals of any species, by better adapting them to their altered conditions, would tend to be preserved; and natural selection would have free scope for the work of improvement.

We have good reason to believe, as shown in the first chapter, that changes in the conditions of life give a tendency to increased variability; and in the foregoing cases the conditions have changed, and this would manifestly be favourable to natural selection, by affording a better chance of the occurrence of profitable variations. Unless such occur, natural selection can do nothing. Under the term of "variations," it must never be forgotten that mere individual differences are included. As man can produce a great result with his domestic animals and plants by adding up in any given direction individual differences, so could natural selection, but far more easily, from having incomparably longer time for action. Nor do I believe that any great physical change, as of climate, or any unusual degree of isolation to check immigration, is necessary in order that new and unoccupied places should be left, for natural selection to fill up by improving some of the varying inhabitants. For as all the inhabitants of each country are struggling together with nicely balanced forces, extremely slight modifications in the structure or habits of one species would often give it an advantage over others; and still further modifications of the same kind would often still further increase the advantage, as long as the species continued under the same conditions of life and profited by similar means of subsistence and defence. No country can be named in which all the native inhabitants are now so perfectly adapted to each other and to the physical conditions under which they live, that none of them could be still better adapted or improved; for in all countries, the natives have been so far conquered by naturalised productions, that they have allowed some foreigners to take firm possession of the land. And as foreigners have thus in every country

beaten some of the natives, we may safely conclude that the natives might have been modified with advantage, so as to have better resisted the intruders.

As man can produce, and certainly has produced, a great result by his methodical and unconscious means of selection, what may not natural selection effect? Man can act only on external and visible characters: Nature, if I may be allowed to personify the natural preservation or survival of the fittest, cares nothing for appearances, except in so far as they are useful to any being. She can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life. Man selects only for his own good: Nature only for that of the being which she tends. Every selected character is fully exercised by her, as is implied by the fact of their selection. Man keeps the natives of many climates in the same country; he seldom exercises each selected character in some peculiar and fitting manner; he feeds a long and a short beaked pigeon on the same food; he does not exercise a long-backed or long-legged quadruped in any peculiar manner; he exposes sheep with long and short wool to the same climate. He does not allow the most vigorous males to struggle for the females. He does not rigidly destroy all inferior animals, but protects during each varying season, as far as lies in his power, all his productions. He often begins his selection by some half-monstrous form; or at least by some modification prominent enough to catch the eye or to be plainly useful to him. Under nature, the slightest differences of structure or constitution may well turn the nicely-balanced scale in the struggle for life, and so be preserved. How fleeting are the wishes and efforts of man! how short his time! and consequently how poor will be his results, compared with those accumulated by Nature during whole geological periods! Can we wonder, then, that Nature's productions should be far "truer" in character than man's productions; that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship?

It may metaphorically be said that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that are good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life. We see nothing of these slow changes in progress, until the hand of time has marked the lapse of ages, and then so imperfect is our view into long-past geological ages, that we see only that the forms of life are now different from what they formerly were.

In order that any great amount of modification should be effected in a species, a variety when once formed must again, perhaps after a long interval of time, vary or present individual differences of the same favourable nature as before; and these must be again preserved, and so onwards step by step. Seeing that individual differences of the same kind perpetually recur, this can hardly be considered as an unwarrantable assumption. But whether it is true, we can judge only by seeing how far the hypothesis accords with and explains the general phenomena of nature. On the other hand, the ordinary belief that the amount of possible variation is a strictly limited quantity is likewise a simple assumption.

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CHAPTER XIV.
RECAPITULATION AND CONCLUSION.

Recapitulation of the difficulties on the theory of Natural Selection — Recapitulation of the general and special circumstances in its favour — Causes of the general belief in the immutability of species — How far the theory of natural selection may be extended — Effects of its adoption on the study of Natural history — Concluding remarks.

AS this whole volume is one long argument, it may be convenient to the reader to have the leading facts and inferences briefly recapitulated.

That many and grave objections may be advanced against the theory of descent with modification through natural selection, I do not deny. I have endeavoured to give to them their full force. Nothing at first can appear more difficult to believe than that the more complex organs and instincts should have been perfected, not by means superior to, though analogous with, human reason, but by the accumulation of innumerable slight variations, each good for the individual possessor. Nevertheless, this difficulty, though appearing to our imagination insuperably great, cannot be considered real if we admit the following propositions, namely,—that gradations in the perfection of any organ or instinct, which we may consider, either do now exist or could have existed, each good of its kind,—that all organs and instincts are, in ever so slight a degree, variable,—and, lastly, that there is a struggle for existence leading to the preservation of each profitable deviation of structure or instinct. The truth of these propositions cannot, I think, be disputed.

It is, no doubt, extremely difficult even to conjecture by what gradations many structures have been perfected, more especially amongst broken and failing groups of organic beings; but we see so many strange gradations in nature, as is proclaimed by the canon, "Natura non facit saltum," that we ought to be extremely cautious in saying that any

organ or instinct, or any whole being, could not have arrived at its present state by many graduated steps. There are, it must be admitted, cases of special difficulty on the theory of natural selection; and one of the most curious of these is the existence of two or three defined castes of workers or sterile females in the same community of ants; but I have attempted to show how this difficulty can be mastered.

With respect to the almost universal sterility of species when first crossed, which forms so remarkable a contrast with the almost universal fertility of varieties when crossed, I must refer the reader to the recapitulation of the facts given at the end of the eighth chapter, which seem to me conclusively to show that this sterility is no more a special endowment than is the incapacity of two trees to be grafted together, but that it is incidental on constitutional differences in the reproductive systems of the intercrossed species. We see the truth of this conclusion in the vast difference in the result, when the same two species are crossed reciprocally; that is, when one species is first used as the father and then as the mother.

* * *

I have now recapitulated the chief facts and considerations which have thoroughly convinced me that species have changed, and are still slowly changing by the preservation and accumulation of successive slight favourable variations. Why, it may be asked, have all the most eminent living naturalists and geologists rejected this view of the mutability of species? It cannot be asserted that organic beings in a state of nature are subject to no variation; it cannot be proved that the amount of variation in the course of long ages is a limited quantity; no clear distinction has been, or can be, drawn between species and well-marked varieties. It cannot be maintained that species when intercrossed are invariably sterile, and varieties invariably fertile; or that sterility is a special endowment and sign of creation. The belief that species were immutable productions was almost unavoidable as long as the history of the world was thought to be of short duration; and now that we have acquired some idea of the lapse of time, we are too apt to assume, without proof, that the geological record is so perfect that it would have afforded us plain evidence of the mutation of species, if they had undergone mutation.

But the chief cause of our natural unwillingness to admit that one species has given birth to other and distinct species, is that we are always slow in admitting any great change of which we do not see the intermediate steps. The difficulty is the same as that felt by so many geologists, when Lyell first insisted that long lines of inland cliffs had been

formed, and great valleys excavated, by the slow action of the coast-waves. The mind cannot possibly grasp the full meaning of the term of a hundred million years; it cannot add up and perceive the full effects of many slight variations, accumulated during an almost infinite number of generations.

Although I am fully convinced of the truth of the views given in this volume under the form of an abstract, I by no means expect to convince experienced naturalists whose minds are stocked with a multitude of facts all viewed, during a long course of years, from a point of view directly opposite to mine. It is so easy to hide our ignorance under such expressions as the "plan of creation," "unity of design," &c., and to think that we give an explanation when we only restate a fact. Any one whose disposition leads him to attach more weight to unexplained difficulties than to the explanation of a certain number of facts will certainly reject my theory. A few naturalists, endowed with much flexibility of mind, and who have already begun to doubt on the immutability of species, may be influenced by this volume; but I look with confidence to the future, to young and rising naturalists, who will be able to view both sides of the question with impartiality. Whoever is led to believe that species are mutable will do good service by conscientiously expressing his conviction; for only thus can the load of prejudice by which this subject is overwhelmed be removed.

Several eminent naturalists have of late published their belief that a multitude of reputed species in each genus are not real species; but that other species are real, that is, have been independently created. This seems to me a strange conclusion to arrive at. They admit that a multitude of forms, which till lately they themselves thought were special creations, and which are still thus looked at by the majority of naturalists, and which consequently have every external characteristic feature of true species,—they admit that these have been produced by variation, but they refuse to extend the same view to other and very slightly different forms. Nevertheless they do not pretend that they can define, or even conjecture, which are the created forms of life, and which are those produced by secondary laws. They admit variation as a vera causa in one case, they arbitrarily reject it in another, without assigning any distinction in the two cases. The day will come when this will be given as a curious illustration of the blindness of preconceived opinion. These authors seem no more startled at a miraculous act of creation than at an ordinary birth. But do they really believe that at innumerable periods in the earth's history certain elemental atoms have been commanded suddenly to flash into living tissues? Do they believe that at each supposed act of creation one individual or many were produced? Were all the infinitely numerous

kinds of animals and plants created as eggs or seed, or as full grown? and in the case of mammals, were they created bearing the false marks of nourishment from the mother's womb? Although naturalists very properly demand a full explanation of every difficulty from those who believe in the mutability of species, on their own side they ignore the whole subject of the first appearance of species in what they consider reverent silence.

It may be asked how far I extend the doctrine of the modification of species. The question is difficult to answer, because the more distinct the forms are which we may consider, by so much the arguments fall away in force. But some arguments of the greatest weight extend very far. All the members of whole classes can be connected together by chains of affinities, and all can be classified on the same principle, in groups subordinate to groups. Fossil remains sometimes tend to fill up very wide intervals between existing orders. Organs in a rudimentary condition plainly show that an early progenitor had the organ in a fully developed state; and this in some instances necessarily implies an enormous amount of modification in the descendants. Throughout whole classes various structures are formed on the same pattern, and at an embryonic age the species closely resemble each other. Therefore I cannot doubt that the theory of descent with modification embraces all the members of the same class. I believe that animals have descended from at most only four or five progenitors, and plants from an equal or lesser number.

Analogy would lead me one step further, namely, to the belief that all animals and plants have descended from some one prototype. But analogy may be a deceitful guide. Nevertheless all living things have much in common, in their chemical composition, their germinal vesicles, their cellular structure, and their laws of growth and reproduction. We see this even in so trifling a circumstance as that the same poison often similarly affects plants and animals; or that the poison secreted by the gall-fly produces monstrous growths on the wild rose or oak-tree. Therefore I should infer from analogy that probably all the organic beings which have ever lived on this earth have descended from some one primordial form, into which life was first breathed.

When the views entertained in this volume on the origin of species, or when analogous views are generally admitted, we can dimly foresee that there will be a considerable revolution in natural history. Systematists will be able to pursue their labours as at present; but they will not be incessantly haunted by the shadowy doubt whether this or that form be in essence a species. This I feel sure, and I speak after experience, will be no slight relief. The endless disputes whether or not some fifty species of British brambles are true species will cease.

Systematists will have only to decide (not that this will be easy) whether any form be sufficiently constant and distinct from other forms, to be capable of definition; and if definable, whether the differences be sufficiently important to deserve a specific name. This latter point will become a far more essential consideration than it is at present; for differences, however slight, between any two forms, if not blended by intermediate gradations, are looked at by most naturalists as sufficient to raise both forms to the rank of species. Hereafter we shall be compelled to acknowledge that the only distinction between species and well-marked varieties is, that the latter are known, or believed, to be connected at the present day by intermediate gradations, whereas species were formerly thus connected. Hence, without quite rejecting the consideration of the present existence of intermediate gradations between any two forms, we shall be led to weigh more carefully and to value higher the actual amount of difference between them. It is quite possible that forms now generally acknowledged to be merely varieties may hereafter be thought worthy of specific names, as with the primrose and cowslip; and in this case scientific and common language will come into accordance. In short, we shall have to treat species in the same manner as those naturalists treat genera, who admit that genera are merely artificial combinations made for convenience. This may not be a cheering prospect; but we shall at least be freed from the vain search for the undiscovered and undiscoverable essence of the term species.

The other and more general departments of natural history will rise greatly in interest. The terms used by naturalists of affinity, relationship, community of type, paternity, morphology, adaptive characters, rudimentary and aborted organs, &c., will cease to be metaphorical, and will have a plain signification. When we no longer look at an organic being as a savage looks at a ship, as at something wholly beyond his comprehension; when we regard every production of nature as one which has had a history; when we contemplate every complex structure and instinct as the summing up of many contrivances, each useful to the possessor, nearly in the same way as when we look at any great mechanical invention as the summing up of the labour, the experience, the reason, and even the blunders of numerous workmen; when we thus view each organic being, how far more interesting, I speak from experience, will the study of natural history become!

A grand and almost untrodden field of inquiry will be opened, on the causes and laws of variation, on correlation of growth, on the effects of use and disuse, on the direct action of external conditions, and so forth. The study of domestic productions will rise immensely in value. A new variety raised by man will be a far more important and interesting subject

for study than one more species added to the infinitude of already recorded species. Our classifications will come to be, as far as they can be so made, genealogies; and will then truly give what may be called the plan of creation. The rules for classifying will no doubt become simpler when we have a definite object in view. We possess no pedigrees or armorial bearings; and we have to discover and trace the many diverging lines of descent in our natural genealogies, by characters of any kind which have long been inherited. Rudimentary organs will speak infallibly with respect to the nature of long-lost structures. Species and groups of species, which are called aberrant, and which may fancifully be called living fossils, will aid us in forming a picture of the ancient forms of life. Embryology will reveal to us the structure, in some degree obscured, of the prototypes of each great class.

When we can feel assured that all the individuals of the same species, and all the closely allied species of most genera, have within a not very remote period descended from one parent, and have migrated from some one birthplace; and when we better know the many means of migration, then, by the light which geology now throws, and will continue to throw, on former changes of climate and of the level of the land, we shall surely be enabled to trace in an admirable manner the former migrations of the inhabitants of the whole world. Even at present, by comparing the differences of the inhabitants of the sea on the opposite sides of a continent, and the nature of the various inhabitants of that continent in relation to their apparent means of immigration, some light can be thrown on ancient geography.

The noble science of Geology loses glory from the extreme imperfection of the record. The crust of the earth with its embedded remains must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals. The accumulation of each great fossiliferous formation will be recognised as having depended on an unusual concurrence of circumstances, and the blank intervals between the successive stages as having been of vast duration. But we shall be able to gauge with some security the duration of these intervals by a comparison of the preceding and succeeding organic forms. We must be cautious in attempting to correlate as strictly contemporaneous two formations, which include few identical species, by the general succession of their forms of life. As species are produced and exterminated by slowly acting and still existing causes, and not by miraculous acts of creation and by catastrophes; and as the most important of all causes of organic change is one which is almost independent of altered and perhaps suddenly altered physical conditions, namely, the mutual relation of organism to organism,—the improvement of one being entailing the

improvement or the extermination of others; it follows, that the amount of organic change in the fossils of consecutive formations probably serves as a fair measure of the lapse of actual time. A number of species, however, keeping in a body might remain for a long period unchanged, whilst within this same period, several of these species, by migrating into new countries and coming into competition with foreign associates, might become modified; so that we must not overrate the accuracy of organic change as a measure of time. During early periods of the earth's history, when the forms of life were probably fewer and simpler, the rate of change was probably slower; and at the first dawn of life, when very few forms of the simplest structure existed, the rate of change may have been slow in an extreme degree. The whole history of the world, as at present known, although of a length quite incomprehensible by us, will hereafter be recognised as a mere fragment of time, compared with the ages which have elapsed since the first creature, the progenitor of innumerable extinct and living descendants, was created.

In the distant future I see open fields for far more important researches. Psychology will be based on a new foundation, that of the necessary acquirement of each mental power and capacity by gradation. Light will be thrown on the origin of man and his history.

Authors of the highest eminence seem to be fully satisfied with the view that each species has been independently created. To my mind it accords better with what we know of the laws impressed on matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and death of the individual. When I view all beings not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Silurian system was deposited, they seem to me to become ennobled. Judging from the past, we may safely infer that not one living species will transmit its unaltered likeness to a distant futurity. And of the species now living very few will transmit progeny of any kind to a far distant futurity; for the manner in which all organic beings are grouped, shows that the greater number of species of each genus, and all the species of many genera, have left no descendants, but have become utterly extinct. We can so far take a prophetic glance into futurity as to foretel that it will be the common and widely-spread species, belonging to the larger and dominant groups, which will ultimately prevail and procreate new and dominant species. As all the living forms of life are the lineal descendants of those which lived long before the Silurian epoch, we may feel certain that the ordinary succession by generation has never once been broken, and that no cataclysm has desolated the whole world. Hence we may look with some

confidence to a secure future of equally inappreciable length. And as natural selection works solely by and for the good of each being, all corporeal and mental endowments will tend to progress towards perfection.

It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us. These laws, taken in the largest sense, being Growth with Reproduction; Inheritance which is almost implied by reproduction; Variability from the indirect and direct action of the external conditions of life, and from use and disuse; a Ratio of Increase so high as to lead to a Struggle for Life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less-improved forms. Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. 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.

De Potentia Dei
St. Thomas Aquinas

Q. IV: ARTICLE II

Was Matter Formed All At Once Or by Degrees?

[Parallel: Sum. Th. I Q. lxvii-lxxii]

THE second point of inquiry is whether matter was formed all at once or by degrees: and seemingly it was formed by degrees.

1. It is written (Judith ix, 4) Thou hast done the things of old and hast devised one thing after another. Now, with God to devise is to act according to Damascene (De Fide Orthod. ii, 3) hence the text quoted continues: And what thou hast designed hath been done. Therefore things were made in a certain order and not all at once.
2. Several parts of time cannot be together at once, because the whole of time is successive. Now according to Genesis i, things were formed at various times. Therefore seemingly things were formed by degrees and not all at once.
3. It will be said, perhaps, that according to Augustine (De Civ. Dei ii, 7, 9) those six days are not the days or divisions of time to which we are accustomed, but a six-fold manifestation of things to the angelic mind corresponding to the six classes of things.—On the contrary day is caused by the presence of light, whereupon it is written (Gen. 1, 5) that God called the light day. And light properly speaking is not found in spiritual creatures but only in a metaphorical sense. Therefore neither can the angels' knowledge be, called day properly speaking. Consequently it would seem not to be a literal exposition of the text to take day as signifying the angelic knowledge. The minor premise is proved thus: Nothing that is a direct object of the senses properly is applicable to the spiritual world: for such things as are common to sense and spirit are not sensible except indirectly, for instance substance, power, virtue and the like. Now light is the direct object of the sense of sight. Hence it cannot be applied properly speaking to spiritual things.
4. An angel has two ways of knowing things, in the Word and in their own nature: consequently 'day' must refer to the one, or the other. It cannot signify his knowledge of things in the Word since this is only one in relation to all those things: because an angel, whatsoever things he knows, knows them simultaneously and by one knowledge, seeing that he knows them in the Word. Thus there would be but one day. On the other

band if it refer to his knowledge of things in their respective natures, it would follow that there were many more than six days, inasmuch as there are many genera and species of creatures. Hence it would seem that the six days cannot refer to the angelic knowledge.
5. It is written (Exod. xx, 9, 10): Six days shalt thou labour but on the seventh day is the Sabbath of the Lord thy God thou shalt do no work on it: and afterwards the reason is given (verse ii): For in six days the Lord made heaven and earth and the sea and all things that are in them, and rested on the seventh day. Now in permitting work on six days and forbidding it on the seventh the Law speaks of days in the literal and material sense. Therefore the days ascribed to God's works are to be taken in the material sense.
6. If day signifies the angels' knowledge it follows that to make a thing in a day is nothing else but to produce it in the knowledge of the angels. But it does not follow that if a thing is produced in the angels' knowledge it therefore exists in its own nature, but only that it is known by the angels. Consequently we should not be informed about the creation of things in their respective natures, which is contrary to Scripture.
7. The knowledge of any single angel differs from that of any other. If then day signifies an angel's knowledge, there should be as many days as there are angels, and not only six as Scripture tells us.
8. Augustine (Gen. ad lit. ii, 7, 8) says that by the words, God said: Let... be made we are to understand that the thing to be made pre-existed in the Word: that by the words, It was so we understand that knowledge of the thing was produced in the intellectual creature: and by the words, God made we understand that the thing was made in itself. If then day signifies the angels' knowledge, then having said of this or that work, And it was so in reference to the angelic knowledge, it was superfluous to add, The evening and morning were the first—or the second day.
9. But it will be said that these words are added to indicate the spiritual creature's twofold manner of knowing things. One is his knowledge of things in the Word and this is called morning, or morning knowledge: the other is his knowledge of things in their respective nature, and this is called evening, or evening knowledge.—On the contrary, though an angel can at the same time consider several things in the Word, he cannot at the same time consider several things in his own nature, since he understands different things in their respective natures by means of different species. If then each of the six days has both morning and evening, there must needs have been some kind of succession in the six days, and consequently the formation of things did not take place all at once.

10. Several actions cannot proceed from one power at the same time, any more than one straight line can terminate at one end in more than one point: since power terminates in action. Now the consideration of things in the Word and in their respective natures is not one but several actions. Therefore morning and evening knowledge are not simultaneous, and thus again it follows that there was succession in those six days.

11. As stated above (A. i) Augustine explains the division of light from darkness as that of the formed creature from the informed matter which had yet to be formed: so that after one creature had been formed on the part of its matter there still remained another creature to be formed, and consequently matter was not formed all at once.

12. According to Augustine the angels' morning knowledge signifies their knowledge of the Word in whom they knew the creatures yet to be made. But this would not be the case if the creatures whose formation is assigned to the following days were formed at the same time as the angels. Therefore all things were not created at the same time.

13. In spiritual matters a day is spoken of by way of comparison with the material day. Now in the material day morning precedes evening. Therefore in these days evening should not have been mentioned before the morning: Evening and morning were the first day.

14. Between evening and morning is night, and between morning and evening is midday. Hence as Scripture mentions evening and morning, it should have mentioned midday also.

15. Every material day has both evening and morning. But this is not the case with these seven days: for the first has no morning, and the seventh has no evening. Therefore it is unreasonable to compare these days with ours.

16. It might be said that the first day has no morning because morning signified that knowledge of the creature yet to be made which the angel received from the Word: and, before being made, the spiritual creature could not receive from the Word any knowledge of its own future making.—On the contrary from this it follows that the angel at one time existed whereas other creatures were not yet made, but were still to be made. Therefore all things were not made at the same time.

17. The spiritual creature does not acquire knowledge of things beneath it from those things themselves: and thus he does not need their presence in order to know them. Consequently before those things were made he could know them as things to be made in their respective nature and not only in the Word: so that knowledge of a thing to be made would seem to belong to the evening as well as the morning knowledge: and thus according to the foregoing exposition, the second day should have had neither morning nor evening.

18. Those things which are first simply are first in an angel's knowledge: since the fact that things which are last are first known to us is due to our acquiring knowledge through our senses. Now the types of things in the Word are simply prior to the things in themselves. Therefore the angels' knowledge of things in the Word precedes his knowledge of things in their respective natures and consequently the morning should have been mentioned before the evening and this is contrary to the text of Scripture.

19. Things that differ specifically cannot combine to form one. Now knowledge of things in the Word and in their respective natures differ specifically, since the medium of knowledge is entirely different in either case: and, consequently, according to the foregoing exposition, morning and evening could not make one day.

20. The Apostle (1 Cor. xiii, 8, 10) says that knowledge will be destroyed in heaven: and this only refers to the knowledge of 'things in their respective natures, which is the evening knowledge. Now in heaven we shall, be as the angels (Mat. xxii, 30). Therefore evening knowledge is not in the angels.

21. Knowledge of things in the Word surpasses knowledge of them in their respective natures more than the sun's brightness surpasses candle-light. But sunlight renders useless the light of a candle: and therefore much more does the morning knowledge of the angels render their evening knowledge useless.

22. Augustine (Gen. ad lit. vii, 24, 25) queries whether Adam's soul were made apart from his body at the same time as the angels or at the same time as his body. But there would be no purpose in discussing this question if all things were made at the same time, because then the human body was made at the same time as the angels. It would seem then that in Augustine's opinion all things were not made at the same time.

23. The portion of earth from which man's body was made had the form of slime according to Genesis ii, 7: and it had not yet the form of a human body. Therefore forms were not all at the same time produced in matter.

24. An angel's knowledge of a thing in its own nature can be no other but his knowledge through the species bestowed on him by nature: for it cannot be said that he acquires species from the things perceived, since he lacks sensorial organs. Now these species bestowed on the angels are independent of corporeal things: and thus even before things existed angels could know them in their respective natures. Consequently from the fact that angels knew a thing in its own nature we cannot argue that it was brought into being: wherefore the explanation given above would seem unreasonable.

25. The morning knowledge whereby the angels knew things in the Word must needs have been through some species, since all knowledge is such. Now it could not be through a species issuing from the Word, because such a species would be a creature, so that the knowledge produced by it would be evening rather than morning knowledge, since evening knowledge is that which is produced by means of a creature. Nor may it be said that the aforesaid knowledge was acquired by means of a species that is the Word himself, since in that case the angel would see the Word; which he did not do before he was beatified, because the beatific vision consists in seeing the Word. But the angels were not beatified in the first instant of their creation, as neither did the demons sin in that first instant. Therefore if morning signifies the knowledge which angels have in the Word, we must infer that all things were not created at the same time.

26. It will be said, perhaps, that in that instant the angels saw the Word as the type of things to be created, but not as the end of the Blessed.—On the contrary there is only a relative difference between the Word considered as end and considered as type. Now the knowledge of God's relation to creatures is not beatific, seeing that this relation in reality is in the creature rather than in God: and it is only the vision of the divine essence that is beatific. Consequently, as regards the bliss of those who see the Word, it matters not whether they see him as the end of beatitude or as a type.

27. Prophets also are said to have seen the future in the mirror of eternity, inasmuch as they saw the divine mirror as reflecting future events: and then there would be no difference between the angel's morning knowledge and the knowledge of a prophet.

28. It is written (Gen. ii, 5) that God made every plant of the field before it sprung up in the earth, and every herb of the ground before it grew. Now the herbs were brought forth on the third day. Hence some things were made before the third day, and all were not made at the same time.

29. It is written (Ps. ciii, 24) that God made all things in wisdom. Now a wise man does things in an orderly way (Metaph. i, 2). Therefore, seemingly, God did not make all things together, but in order of time and by degrees.

30. It might be said that though order of time was not observed in the creation, the order of nature was.—On the contrary in the order of nature the sun, moon and stars precede the plants, for it is clear that they are causes of plants: and yet we are told that the heavenly, lights were made after the plants. Therefore the order of nature was not observed.

31. The heavenly firmament naturally precedes earth and water, and yet Scripture mentions these before the firmament which we are told was made on the second day.

32. The subject naturally precedes its accident. Now light is an accident and its first subject is the firmament. Therefore the creation of light would not precede that of the firmament.

33. Animals that walk are more perfect than those which swim or fly, principally by reason of their likeness to man: and yet the creation of fishes and birds is related before that of terrestrial animals. Therefore the right order of nature was not observed.

34. Fishes and birds seemingly do not in their respective natures differ from each other more than from terrestrial animals: and yet we are told that fishes and birds were created on the same day. Therefore the days do not correspond to various kinds of things, but rather to various successive times and then all things were not created at the same time.

1. On the contrary it is written (Gen. ii, 4, 5): These are the generations of the heaven and the earth when they were created in the day that the Lord made the heaven and the earth, and every plant of the field. Now we are told that the plants of the field were created on the third day: while heaven and earth were made on the first day, or even before all days. Hence the things made on the third day were created on the same day as those which were made on the first day or before all days: and thus in like manner all things were made at the same time.

2. Again it is written (Job xl, 10): Behold Behemoth whom I made with thee. Now according to Gregory (Moral. xxxii, 9) Behemoth signifies the devil, who was made on the first day or before all days: while man, to whom the Lord's words are addressed, was made on the sixth day. Hence things made on the sixth day were created together with those that were made on the first day: and so we arrive at the same conclusion as before.

3. Again, parts of the universe depend on one another, especially the lower on the higher parts. Therefore it was impossible for some parts to be made before others, especially the lower before the higher.

4. Again there is a greater difference between corporeal and spiritual creatures than between one corporeal creature and another. Now, as we have already shown, the spiritual and corporeal creatures were made at the same time. Therefore, a fortiori, all spiritual creatures were made at the same time.

5. Again by reason of the immensity of his power God works in an instant: and thus the work of each day was accomplished suddenly and instantaneously. Therefore there is no sense in saying that he waited until the next day to do his next work, and remained idle for a whole day.

6. Further if the days mentioned in the story of the creation were ordinary days, it is difficult to understand how the night could be wholly distinct from the day, and light from darkness. For if the light which we are told

was made on the first day enveloped the whole earth, nowhere was there darkness, which is the earth's shadow cast on the side opposite to the light that causes day. And if that light by its movement revolved around the earth so as to cause day and night, then there was always day on one side, and night on the other, and consequently night was not wholly divided from the day, and this is contrary to Scripture.

7. Again the division between day and night is caused by the sun and other heavenly luminaries, wherefore it is written in the story of the fourth day (verse 14): Let there be lights made in the firmament of the heaven and the text continues and let them be for signs and for seasons and for days and years. Seeing then that the effect does not precede its cause, it cannot be that the first three days were of the same kind as the days which are regulated by the sun: and consequently the mention of those days is no proof that things were made one after the other.

8. Moreover if then there was some other light which by its movement caused day and night, there must have been some vehicle with a circular movement to carry this other light and cause a succession of day and night. Now this vehicle would be the firmament which we are told was made on the second day. Therefore at least the first day could not be the same kind of day as those we have now, nor likewise as the other days of the text.

9. Again if that light was made that it might produce day and night, it would also do so now: for it is unreasonable to say that it was made solely to serve this purpose for the three days that preceded the creation of the sun, and that afterwards it ceased to exist. But there is no other light now besides the sun that causes day and night. Therefore neither during those three days was there any other corporeal light to cause the distinction between day and night.

10. Someone might say that this light was afterwards resolved into the solar body.—On the contrary whenever a thing is made out of pre-existent matter, it is composed of a matter susceptive of a succession of forms. But such is not the matter of which the sun or any other heavenly body is composed, because in them there is no contrariety (De coel. et mund. i). Therefore it is impossible that the sun was afterwards formed out of that light.

I answer that in the supposition that formless matter did not precede its formation in point of time but only in point of origin (and it could not be otherwise if formless matter signify matter entirely devoid of form) it follows of necessity that the formation of things was simultaneous, since it is not possible for any part of matter to be even for an instant entirely formless. Besides, as regards that particular part, matter would precede

its formation in point of time. Wherefore if we adopt the opinion of Augustine as discussed in the preceding article, there is no reason to propose the question at the head of this article, and we must state at once that all things were formed at the same time, except in so far as it remains for us to explain in what sense we are to take the six days mentioned by Scripture. For if we are to take them to be like the days we have now, this would be in contradiction with the aforesaid opinion, since then we should have to hold that the formation of things took place during a series of days.

Augustine explains these days in two ways. First in his opinion (Gen. ad lit. i, 17) the distinction of light from darkness signifies the distinction of formed from formless matter which awaited its form, the difference being one not of time but of the order of nature. He holds that the order between formlessness and formation according as all things are ordered by God is implied by day and night, for day and night are an ordering of light and darkness. He says that evening denotes the termination of the work done: and morning the future beginning of the work, future not in the order of time but in the order of nature: for the first work contains already a kind of indication of the future work to be done. According to this view we must take the days as being distinct from one another inasmuch as there were various formations and consequently a lack of various forms.

Since however it would follow from this that the seventh day also was distinct from the first six, if these also were distinct from one another (whence it would seem to follow either that God did not make the seventh day, or that he made something after the seven days wherein he completed his work) he (Augustine) maintained in consequence, that all these seven days were but one, namely the angelic knowledge, and that the number refers to the distinction between the things they knew rather than to a distinction of days: in other words that the six days signify the angel's knowledge in reference to the six classes of things created by God, while one day signifies the angel's knowledge in reference to the Maker's rest, in that he rested in himself from the things be had made: so that evening signifies knowledge of a thing in its own nature, and morning, knowledge in the Word.

According to other holy men these days denote order of time and succession in the production of things. In their opinion there was order not only of nature but also of time and duration in the works of the six days: for they contend that as matter was in a formless condition before its formation, so also one formation preceded another in the order of time. Because (as stated in the preceding article) by the formless condition of matter they did not understand the lack and exclusion of all

form (since heaven, water and earth by which they understood the heavenly bodies, were already in existence, besides spiritual substances, and the four elements under their respective forms) but the mere absence and exclusion of the due distinction and perfect comeliness of each thing, in that it was lacking in that finish and beauty now to be seen in the corporeal creature. Thus we can gather from the text of Genesis, that the corporeal nature was lacking in a threefold beauty, for which reason it is described as being formless.—The heavens and the entire diaphanous body lacked the comeliness and beauty of light: and this is denoted by the darkness. The element of water lacked due order and distinction from the element of earth: and this lack of form is designated by the word deep, which signifies a certain inordinate immensity of the waters according to Augustine (Cont. Faust. xxii, ii).—The earth lacked a twofold beauty: one which it acquired by the withdrawal of the waters, and this is signified by the words: And the earth was void and empty—or invisible, because it could not be seen by reason of the waters covering it on all sides: the other which it acquires through being adorned with plants, and this is indicated when it is said that it was empty or incomposite, i.e. unadorned. Thus then before the work of distinction Scripture mentions a manifold distinction as already existing in the elements of the world from the beginning of its creation. First it mentions the distinction between heaven and earth in so far as the heaven signifies the entire transparent body which includes fire and air on account of their transparency which they have in common with the heaven. Secondly it mentions the distinction of the elements as regards their substantial forms, by naming water and earth which are more perceptible to sense, and thus implying the others which are less apparent. Thirdly it mentions positional distinction: for the earth was beneath the waters which concealed it, while the air which is the subject of darkness is indicated as being above the waters in the words, Darkness was over the face of the deep. Accordingly the formation of the first body, namely the heaven, took place on the first day by the production of light whose illuminating property was communicated to the sun and heavenly bodies which already existed in respect of their substantial forms, and thus their formlessness of darkness was removed. From this formation resulted the distinction of movement and time, namely of night and day, since time is consequent to the movement of the higher heaven. Hence the text mentions the distinction of light and darkness: since the cause of light was in the substance of the sun, and the cause of darkness was in the opaqueness of the earth: so that while there was light in one hemisphere, there was darkness in the other, and again in the one hemisphere light at one time and darkness at another. This is expressed in the words, He

called the light day, and the darkness might.—On the second day took place the formation and distinction of the middle body, namely water, by the formation of the firmament in that it was given parts and order. Thus under the name of water are comprised all transparent bodies: so that the firmament or starry heaven produced on the second day, not in substance, but as to a certain accidental perfection, divided the waters that are above the firmament (from those that are beneath it). By the firmament is meant the whole trans~ parent heaven without the stars, known also as the I aqueous' or crystalline heaven. Philosophers say that it is the ninth sphere and the first moving body, which causes the whole heaven to revolve as a daily movement, and producing by that movement a continuity of generation. In like manner the starry heaven by its zodiacal movement causes diversity in generation and corruption, by approaching to or receding from us and by the varying power of the stars. The waters beneath the firmament are the other corruptible transparent bodies. Consequently these lower transparent bodies signified under the name of waters received from the firmament a certain order and were divided into fitting parts.—On the third day was formed the lowest body, namely the earth, in so far as it was freed of its watery covering, and the lowest division was made of the sea from the dry land. It was thus not unfitting that the text having expressed the formless condition of the earth in the words, The earth. was invisible or empty, should signify its formation in the words And let the dry land appear, and the waters being gathered together into one place apart from the dry land, and God called the dry land Earth, and the gathering together of the waters he called Seas: and whereas the earth was hitherto void and empty he adorned it with plants and herbs.—On the fourth day took place the adornment of the first part of the corporeal creature, which had been divided on the first day, the adornment to wit of the heavens by the creation of the luminaries. These as to their substance were created from the beginning, but whereas then their substance was formless now on the fourth day it is formed, not indeed with a substantial form, but by receiving a certain fixed power, inasmuch as these luminaries were endowed with certain powers for certain effects, as evinced by the different effects produced by solar, lunar or stellar rays. Dionysius (Div. Nom. iv) refers to this distinction of powers when he says that the light of the sun was formed on the fourth day, whereas hitherto it had been formless. If Scripture makes no mention of these luminaries from the outset but only on the fourth day, it was according to Chrysostom. in order to keep the people from idolatry, by showing that the luminaries were not gods, seeing that they did not exist from the beginning.—Qn the fifth day, the second part of corporeal nature which had been divided on the second, day was adorned by the

creation of birds and fishes. Wherefore on this fifth day Scripture mentions the waters and the heavenly firmament, so as to show that the fifth day corresponds to the second, where mention was made of the waters and firmament. On this day then by God's word the birds and fishes in their respective, natures were brought into actual being from the already created elemental matter in order to adorn the air and the water which are a fitting medium for their animal movements.—On the sixth day the third part of corporeal nature and the lowest body, namely the earth, was adorned by the creation of terrestrial animals to which it is connatural to move on the earth. Hence just as in the work of creation the text indicates a threefold division of corporeal creatures, the first signified under the name of heaven, the middle signified under the name of water, and the lowest signified under the name of earth; while the first part, i.e. the heaven was distinguished on the first day and adorned on the fourth, the middle part, i.e. the waters, distinguished on the second day and adorned on the fourth, as we have stated; so was it fitting that the lowest part, i.e. the earth which was distinguished on the third day, should, be adorned on this the sixth day by the terrestrial animals being brought into actual existence and divided into various species.

From all this it is clear that Augustine differs from other holy men in his explanation of the works of the six days. First, by the earth and water first created he understands primal matter utterly devoid of form, and by the creation of the firmament, the gathering together of the waters and by the uncovering of the dry land he understands the introduction of substantial forms into corporeal matter. Whereas the other saints take the earth and water first created to signify the elements of the world existing each under its own form, and the subsequent works to indicate some kind of division of the already existing bodies through their receiving certain powers and accidental properties, as stated above.—Secondly they differ in respect of the production of plants and animals: since the other saints say that these were actually produced in their respective natures during the work of the six days, whereas Augustine holds that they were produced only potentially.—Thirdly in holding (Gen. ad lit. iv, 34) that all the works of the six days took place at the same time Augustine apparently does not differ from the others as to the manner in which things were produced.—First, because both views agree in saying that in the first production of things matter was the subject of the substantial forms of the elements, so that primal matter did not precede the substantial forms of the elements of the world by a priority of duration.—Secondly because both opinions are agreed that in the first production of things by the work of creation plants and animals

were not brought into actual but only potential existence, inasmuch as they could be educed from the elements by the power of God's word.

There is however a fourth point in which they differ. According to the other saints after the first production of the creature when the elements of the world and the heavenly bodies as to their substantial forms were produced, there was a time when there was no light: also when the firmament was not yet formed, or the transparent body adorned and made distinct: also when the earth was still covered with the waters, and as yet the luminaries were not formed. This is the fourth point wherein they differ from the view of Augustine who (l.c.) held that all these things were formed together in the same instant of time.

That the works of the six days according to the other saints were produced not simultaneously but by degrees, was not owing to lack of power in the Creator who could have produced all things at once, but was directed to the manifestation of God's wisdom in the production of things, in that when he made things out of nothing he did not at once bring them from nothingness to their ultimate natural perfection, but conferred on them at first an imperfect being, and afterwards perfected them, so that the world was brought gradually from nothingness to its ultimate perfection. Thus different days corresponded to the various degrees of perfection, and it was shown that things derived their being from God, against those who contended that matter was uncreated, and that moreover he is the author of their perfection, against those who ascribed, the formation of the lower world to other causes.

The first explanation of these things namely that held by Augustine is the more subtle, and is a better defence of Scripture against the ridicule of unbelievers: but the second which is maintained by the other saints is easier to grasp, and more in keeping with the surface meaning of the text. Seeing however that neither is in contradiction with the truth of faith, and that the context admits of either interpretation, in order that neither may be unduly favoured we now proceed to deal with the arguments on either side.

Reply to the First Objection. In the divine works order of nature and origin and not of duration was observed. Formless spiritual and corporeal natures were formed first by priority of nature and origin. And though both natures were formed at the same time; inasmuch as the spiritual nature naturally transcends the corporeal, its formation preceded that of the corporeal nature in the order of nature. Again since an incorruptible corporeal nature transcends a corruptible nature, it behoved the former to be formed first in the order of nature. Wherefore on the first day the formation of the spiritual nature is signified by the creation of light,

whereby the mind of the spiritual creature was illumined through its conversion to the Word. On the second day the formation of the corporeal nature heavenly and incorruptible, is signified by the creation of the firmament, which we understand to include the production of all the heavenly bodies and their distinction in respect of their various forms. — On the third day the formation of the corporeal nature of the four elements is signified by the gathering together of, the waters and the appearance of the dry land.—On the fourth day the adornment of the heaven is signified by the creation of the luminaries, and this in the order of nature should precede the adornment of the waters and the earth which took place on the following days. Thus God's works were wrought in order indeed, not of duration but of nature.

Reply to the Second Objection. Things were not formed by degrees nor at various times: all these days which the text assigns to God's works are but one day described as present to each of the six classes of things and numbered accordingly: even so God's Word by whom all things were made is one, namely the Son of God, and yet we read repeatedly God said... And just as those works persevere in his subsequent works which are propagated from them by the agency of nature, so do, those six days continue throughout the succeeding time. This may be made clear as follows. The angelic nature is intellectual and is properly described as light, and thus the enlightening of the angel should be called day. Now the angelic nature when things were first created was given the knowledge of these things, so that in a manner of speaking the light of the angel's intellect was made present to the things created, in so far as they were made known to the light of his mind. Hence this knowledge of things, implying that the light of the angelic intellect is made present to the things known, is called day: and various days are distinguished and ordered according to the various classes and order of the things known. Thus the first day is the knowledge of God's first work in forming the spiritual creature and converting it to the Word.—The second day is the knowledge of the second work whereby the higher corporeal creature was formed by the creation of the firmament.—The third day is the knowledge of the third work of the formation of the corporeal creature in respect of the lower part, namely the earth, water and neighbouring air.—The fourth day is the knowledge of the fourth work or the adornment of the higher part of the corporeal creature, that is of the firmament by the creation of luminaries.—The fifth day is the knowledge of the fifth divine work whereby the air and water were adorned by the creation of birds and fishes.—The sixth day is the knowledge of God's sixth work, namely of the adornment of the earth by the, creation of terrestrial animals.—The seventh day is the angelic knowledge as referred

to the Maker's rest in that he rested in himself from the production of new works.

Now since God is all light, and there is no darkness in him, God's knowledge in itself is pure light: whereas the creature through being made from nothing contains within itself the darkness of potentiality and imperfection, and consequently the knowledge of which a creature is the object must needs be mingled with darkness. Now a creature may be known in two ways: either in the Word, as the outcome of the divine scheme, and thus the knowledge of it is called morning knowledge, because as the morning is the end of darkness and the beginning of light, so the creature, whereas before it was not in existence, receives a beginning of light from the light of the Word. Secondly a creature is known as existing in its own nature: and this is called evening knowledge, because as the evening is the end of light and verges into night, so the creature as subsistent in itself terminates the operation of the light of the divine Word, in that it is made thereby, and of itself would fall into the darkness of its deficiencies were it not upheld by the Word. And so this knowledge being divided into morning and evening is called day: for just as in comparison with the Word's knowledge it is darksome, so in comparison with that ignorance which is darksome, it is light. In this way we may observe a certain circular movement of day and night, inasmuch as the angel knowing himself in his own nature referred this knowledge to the praise of the Word as his end, and in the Word as principle received the knowledge of the next work. And as this morning is the end of the preceding day so is it the beginning of the next day: for day is a part of time and the effect of light. And the distinction of those first days is not a distinction of different times, but refers to the spiritual light according as divers and distinct classes of things were made known to the angelic mind.

Reply to the Third Objection. The statement that light properly speaking is not in spiritual things, is untrue. For Augustine (Gen. ad lit. iv, 24) says that in spiritual things light is better and more certain; also that light is said of Christ otherwise than stone; for he is light properly speaking, and stone metaphorically. The reason is that all that is made manifest is light (Eph. iv, 13): and manifestation belongs more properly to spiritual than to corporeal things. Hence Dionysius (Div. Nom. iv) numbers light among the intelligible names of God, and intelligible names belong properly to the spiritual world. In proof of the opposite statement it is said that the name light was first employed to signify the cause of manifestation to sight: and in this. way light is a quality directly perceptible to sense, and is not properly applied to spiritual things. It is however extended by common use so as to signify anything that causes a manifestation in any kind of

knowledge; so that it bears this signification in ordinary language and in this way light belongs more properly to spiritual things.

Reply to the Fourth Objection. As we have stated above, these days are differentiated not in respect of succession in knowledge, but according to the natural order of the things known. Hence Augustine (De Civ. Dei xiv, 7, 9) holds that these seven days are one day represented by things in seven ways. Consequently the order of the days should be referred to the natural order of the works, which are assigned to days, each day corresponding to certain things which by the angelic intellect are known simultaneously in the Word.

Reply to the Fifth Objection. The six days wherein God is said to have created the heaven, the earth, the sea and an that are in them, do not signify a succession of time, but the angelic knowledge as referred to six classes of things created by God, while the seventh day is the angel's knowledge as referred to the rest of the Maker. For in Augustine's opinion (Gen. ad lit. iv, 15) God is said to have rested on the seventh day inasmuch as he revealed to the angelic mind the rest whereby he rested in himself from the things created, whereby he is happy in himself and needs not creatures, being all-sufficient to himself: and this knowledge Augustine calls day.—God is said to have rested from work on the seventh day, because afterwards he did nothing new that in some way did not already exist either materially or causally or in respect of some specific or generic likeness in the works of the six days.—And whereas after the completion of all his works God rested in himself on the seventh day, Scripture and the Law commanded the seventh day to be kept holy. For then especially is a thing holy when it rests in God; thus things dedicated to God (e.g. the tabernacle, the vessels, the ministers) are called holy things. Now the seventh day was dedicated to the worship of God and for this reason it is said to be kept holy. Accordingly as God after producing six classes of creatures and making them known to the angelic mind, rested not indeed in the things he had created as though they were his end, but in himself and from the things he had created: inasmuch as he himself is his own beatitude (since he is not made happy by making things, but through being all-sufficient to himself and heeding not the things he made),—even so are we to learn to rest not in God's works nor in ours, but from work and in God in whom our happiness consists. In fact for this very reason was man commanded' to labour in his own works for six days, and to rest on the seventh applying himself to the worship of God and resting in the meditation of divine things, wherein his sanctification chiefly consists.

Again the newness of the world proves in a striking manner the existence of God and that he needs not creatures: wherefore man was commanded in the Law to rest and hold festival on the seventh day which saw the

completion of the world, in order that the novelty of the world produced all at once and the six different classes of things might keep man in continual remembrance of God, and lead him to give thanks to him for the great and fruitful boon of the creation, so as to rest his thoughts in him as his end, in this life by grace, in the future life by glory.

Reply to the Sixth Objection. Every new work of God as referred to the angelic knowledge is called a day: and as there were but six classes of things created in the beginning by God and made known to the angelic intellect, as stated above, so are there but six days: to which the seventh is added, namely the same angelic knowledge as referred to God's rest in himself. For God produced nothing in nature without first, in the order of nature, making it known to the angel's mind.

The Reply to the Seventh Objection is clear from what has been said: because these days are not differentiated in relation to a difference in the angelic knowledge, but by the different primordial works as referred to that knowledge: so that those first days are distinct in reference to different works and not in reference to different knowledges. Hence these six days are distinct according as the light of the angelic mind is shed on the six classes of things made known to it.

Reply to the Eighth Objection. According to Augustine these three denote the threefold being of things. First, their being in the Word: for things have being in the divine art which is his Word, before they have being in themselves: and this is signified by the words, God said: Let... be made, i.e. He begot the Word in whom things were before they were made.—Secondly, things have being in the angelic mind, because God created nothing in nature, without having previously revealed its nature to the angelic mind: and this is signified in the words, it was so done, namely by the outpouring of the Word into the angel's intellect.—Thirdly, things have being in their own nature: and this is signified when it is said, He made. For even as the art to which the creature is fashioned is in the Word before it is produced in the creature so in the order of nature was knowledge of that same art in the angelic mind before the creature was produced. Thus the angel has a threefold knowledge of things, namely as they are in the Word, as they are in his mind, and as they are in their respective natures. The first is called morning' knowledge, while the other two are included in evening' knowledge: and in order to indicate this twofold mode of a spiritual creature's knowledge of things, it is said: Evening and morning were one day. Accordingly by these six days wherein we read that God made all things, Augustine understands (De Civ. Dei xi, 9) not these ordinary days that are measured by the course of the sun, since we are told that the sun was created on the fourth day, but one day, that is the angelic knowledge made present to the six classes of things.

Thus even as the presence of a corporeal luminary by its shining on this lower world makes a temporal day, so the presence of the spiritual light of the angelic mind by its shining on creatures makes a spiritual day: so that in his opinion these six days are differentiated according as the light of the angel's intellect shines on the six classes of things made known to it: and the first day is his knowledge of God's first work, the second day, his knowledge of the second work, and so on. Consequently these six days differ not in the order of time or of the succession of things, but in the natural order of the things known, in so far as one thing was known before another in the order of nature. And just as in a natural or material day the morning is the beginning and the evening the end and term, even 'so the angel's knowledge of each work in its original being, namely as having its being in the Word, is called morning knowledge: while the knowledge thereof in respect of its ultimate being, and as existing in its own nature, is called evening knowledge. For the origin of everything's being lies in the cause whence it issues: while its term lies in its recipient which terminates the action of its cause. Wherefore the first knowledge of a thing is the consideration thereof in the cause whence it comes: while the ultimate knowledge of a thing is the consideration of that thing in itself. Since then the being of things issues from the eternal Word as from their original principle, and this issue terminates in the being that things have in their respective natures, it follows that knowledge of things in the Word which has for its object their first and original being, should be called morning knowledge, by way of comparison with the morning which is the beginning of day: whereas knowledge of a thing in its own nature, which has for its object its ultimate and terminated being, should be called evening knowledge since the evening ends day. Hence as the six classes of things in relation to the angelic knowledge differentiate the days, even so the unity of the thing known which is knowable by various modes of cognition constitutes the unity of the day, which itself is divided into evening and morning.

Reply to the Ninth Objection. An angel is unable directly and principally to understand in their own natures several things, but he is well able to understand several things indirectly as related to one intelligible object. And whereas all things that were produced in their respective natures, were in the order of nature first impressed in the shape of images on the angelic mind, the angel by knowing himself, at the same time, so to say, knows those six classes of things in their natural mutual co-ordination, since by knowing himself, he knows whatsoever has being in himself.

Reply to the Tenth Objection. One power can exercise two operations at the same time, if one of these is referred and ordered to the other; 'thus it is evident that the will at the same time wills the end and the means,

and the intellect at the same time understands the premises and the conclusions through the premises, provided that it knows the conclusions. Now the angels' evening knowledge is ordered to their morning knowledge, according to Augustine (Dial. lxv QQ. qu. 26: Super Genes. ii, 3, 8), just as natural knowledge and love are ordered to heavenly knowledge and love. Wherefore nothing hinders an angel from having at the same time morning and evening knowledge, just as natural and heavenly knowledge are together. For one power cannot exercise at the same time two operations that proceed from two species of the same kind, if the one be not ordered to the other (and such are all created non-subsistent intelligible species), so that an angel cannot at the same time produce several intellectual acts by means of several concreated species. But if those two operations proceed from forms generically different and disparate one of which is ordered to the other (and such are a subsistent uncreated form, and a non-subsistent created form), then they can be produced simultaneously. Wherefore since the angel's knowledge of things in their respective natures, which is called evening knowledge is exercised by means of a created non-subsistent intelligible species, while his knowledge of things in the Word, which is called morning knowledge is exercised through the subsistent essence of the Word; and since these two are generically distinct and disparate, yet one is ordered to the other, it follows that both knowledges can be exercised at the same time. The reason is that a concreated species inhering in the intellect is not incompatible with the union of the intellect to the essence of the Word, which actuates the intellect not in respect of being but only in respect of understanding, inasmuch as it is disparate and of a higher order, and this same inherent species and whatsoever of perfection there is in the created intellect are by way of a material disposition to that union and blessed vision whereby things are seen in the Word. Hence just as disposition to a form and the form itself can coexist in that which is actually complete, so the inhering intelligible species coexists with the intellect's union to the essence of the Word, in the intellect's perfect operation. Wherefore a twofold operation issues simultaneously from the intellect of the blessed angel; one by reason of its union to the essence of the Word and whereby it sees things in the Word, and this is called morning knowledge; the other by reason of the species inhering to it, whereby it sees things in their own nature, and this is called evening knowledge. Neither of these actions is weakened or lessened by attention to the other, on the contrary it is strengthened, seeing that the one leads to the other, even as the imagination of what one has seen is more vivid when the thing is actually present to the eye. For the action whereby the blessed see the Word and things in the Word is the reason of their every

action. And when of two actions one is the reason of the other or is ordered to the other, both of them can be exercised at once by the same power. In that case the one power terminates in different actions in respect of different species mutually ordered the one to the other, not in the same respect but in different respects. For species that differ in genus and order, or that are disparate, can be united together in respect of a perfect act, for instance colour, smell and taste in fruit. Now the divine essence, whereby the angel's intellect sees things in the Word is uncreated and self-subsistent: the essence of an angel whereby he sees always himself and things as having being in himself is created and self-subsistent by reason of the being he had received and by which his intellect subsists; and the infused or concreated intelligible species, whereby he sees things in their own nature is non-subsistent: wherefore these three are different in order and genus, and disparate, so that the first is as it were the reason of the others, and the second the reason of the third: consequently the angelic intellect will be able to have a threefold operation in respect of those three forms. Even so the soul of Christ at the same time understands things by the species of the Word, as by infused, and by acquired species.

Reply to the Eleventh Objection. just as in the opinion of Augustine (Ad Oros. qu. xxi) the informity of matter preceded its formation by priority not of time but of order (as sound and voice precede the song), so the formation of the spiritual nature signified in the creation of light, since this is more noble than the corporeal nature, preceded the formation of the latter in the order of nature and origin but not of time. Now the formation of the spiritual nature consists in its being enlightened so as to adhere to the Word, not indeed by perfect glory, with which it was not created, but by perfect grace with which it was created. Accordingly by this light the distinction was made from darkness, to wit from the formless condition of the corporeal creature as yet unformed, yet in the order of nature to be formed afterwards. Because the formation of the spiritual creature may be taken in two ways. First, as denoting the infusion of grace, second, as denoting the conservation of glory. The former according to Augustine was vouchsafed the spiritual creature from the very first instant of its creation, in which case the darkness from which the light was divided does not denote the sin of the wicked angels, but the formless condition of nature which was not yet formed, but in the order of nature was to be formed in the subsequent works (Gen. ad lit. i, 5, 6, 7).—Or again (Super Gen. iv, 22, 23) day signifies God's knowledge, night the creature's, which latter is darkness in comparison with God's (ibid.).—Or again if darkness be taken to signify the wicked angels, then this distinction refers to their sin not as present but as future to God's

foreknowledge. Hence (Ad Oros. qu. xxiv) he says: "God foreseeing that some of his angels would fall through pride, by the unchangeable order of his foreknowledge, divided the good from the wicked, and called the wicked darkness, the good, light."

The second formation of the spiritual nature does not belong to the beginning of things, but rather to their course in which they are governed by divine providence. Hence the distinction of light from darkness, if by darkness we understand the sins of the demons, must be taken in reference to God's foreknowledge. Wherefore Augustine says (De Civ. Dei xi, 19) that he alone could divide light from darkn,ess who before the angels fell could foresee that they would fall. But if by darkness we understand the formless condition of matter yet to be formed, the order is signified not of time but of nature between the formations of both natures.

Reply to the Twelfth Objection. If we suppose that all things were created at the same time as to both matter and form, then the angel is said to have been cognisant of the future creation of the corporeal creature, not as though the corporeal creature were future in point of time, but because it was known as future inasmuch as it was seen in its cause in which it existed already as something that could issue therefrom. Thus he who knows a chest in the materials of which it is made, may be said to know the chest as a future thing. For the knowledge of a thing in the Word is called 9 morning' knowledge, whether the thing is already made or has to be made, and refers indifferently to present or future things, since it is conformed to the divine knowledge whereby God knows all things simply before they are made as well as after they have been made. Nevertheless all knowledge of a thing in the Word refers to that thing as yet to be made, whether it be already made or not, in so far as 'yet to be made ' indicates not time but the issue of the creature from its Creator. Even so the artificer has in his art the knowledge of the work he produces, but that knowledge refers to the work as something he intends to make even when it has already been made. Wherefore for this reason, although the corporeal creature was made at the same time as the spiritual nature, the angel is nevertheless said to have known the corporeal creature in the Word as something yet to be made, for the reason already given.

Reply to the Thirteenth Objection. Even as morning precedes evening, so the morning precedes the evening knowledge in the order of nature, not in respect of one and the same work but in respect of different works. Nevertheless evening knowledge of a prior work is understood to precede morning knowledge of a later work. For the work of the first day was the creation of light, whereby we understand the formation of the angelic nature by the enlightenment of grace; while the knowledge whereby the

spiritual creature knows himself is consequent to its being in his own nature. Hence in the order of nature the spiritual creature knew himself in his own nature by 'evening' knowledge whereby he knew himself as already created, before he knew himself in the Word in whom he knew God's work as something yet to be done. Accordingly in this knowledge whereby the good angels knew themselves they did not rest, as making themselves the object of their fruition and their own end, because then they would become night as the wicked angels who sinned, but they referred their knowledge to the praise of God. Thus by his knowledge of himself the good angel was converted to the contemplation of the Word, and this was the beginning of the following day, because in the Word he received knowledge of the following work, namely the firmament. Now just as in continuous time the same 'now' belongs to two periods of tirae, inasmuch as it is the end of the past and the beginning of the future, even so the ' morning ' knowledge of the second day terminates the first day and begins the second day, and so on to the seventh day. Consequently on the first day evening alone is mentioned, since the angel first had 'evening' knowledge of himself, and that evening knowledge went forward to 'morning' knowledge, in so far as from contemplation of himself he advanced to the contemplation of the Word, and to the morning, of the next day by receiving in the Word the morning knowledge of the next work. Thus then morning knowledge of one and the same work after the first work naturally precedes the 'evening' knowledge of the same work: but evening knowledge of a previous work naturally precedes morning knowledge of a later work: wherefore as the first day had only an evening, so the seventh day through signifying contemplation of God, which being faultless never wanes has only a morning.

Reply to the Fourteenth Objection. Augustine gives the name of morning knowledge to that which is in full light, so that it includes mid-day knowledge: in fact he calls it sometimes day sometimes morning knowledge.—Or else it may be said that all knowledge of the angelic intellect has a mixture of darkness on the part of the knower, so that no knowledge of an angelic intellect can be called mid-day knowledge, but only that knowledge whereby God knows all things in himself.—Again, since God is all light and no darkness is in him, the knowledge, of God, being all light, ,may in itself and absolutely be called mid-day knowledge: whereas a creature being made from nothing has the darkness of potentiality and imperfection, and consequently the knowledge of a creature is mixed with darkness. This mixture is signified by morning and evening, for as much as a creature can be known in two ways.—First in the Word, according as the creature issues from the divine art,—and thus the knowledge thereof is called morning knowledge. because as morning

is the end of darkness and the beginning of light, so the creature after darkness, namely after nonexistence, receives a beginning of light from the Word. Secondly the creature is knowable in its own nature by means of a created species, and such knowledge is called evening knowledge, since just as evening is the end of light and verges into night, even so the creature as subsistent in itself is the end of the operation of the Word who is light, in that it is made by him, and so far as it is concerned tends to the darkness of non-existence unless it were upheld by the Word. And yet this knowledge is called day, because as in comparison with the knowledge of the Word it is darksome, so in comparison with ignorance which is altogether darksome, it is called light; even so the life of the just man is said to be darksome as compared with the life of glory, and yet is called light in comparison with the life of the wicked.Again seeing that morning and evening are parts of a day, and that day in the angels is knowledge illumined by the light of grace, it follows that morning and evening knowledge extend only to the gratuitously bestowed knowledge of the good angels, so that the enlightened angel's knowledge of God's works is called day, and the days are distinguished in reference to the various kinds of divine works as known, and are arranged according to their order. Now each of those works is known by the enlightened angel in two ways. First in the Word or by the species of the Word, and this is called morning knowledge. Secondly, in its own nature, or by a created species. In this knowledge the good angels do not rest as making it their end, because they would become night like the wicked angels: but they refer that knowledge to the praise of the Word and the light of God in whom they know all things as in their source. Wherefore this knowledge of the creature being referred to God is not called night: which it would be were they to rest therein, since they would become night through making a creature the object of their fruition. Accordingly, morning and evening knowledge are divisions of the day, i.e. the knowledge which the good enlightened angels have of the works of creation. Now the good angels' knowledge of a creature, whether through a created or an uncreated medium, has always an element of obscurity; and so it is not called mid-day knowledge as the knowledge of God in himself is; nor is it called night, as that knowledge of a creature which is not referred to the divine light, but it is called morning and evening knowledge, for this reason that evening as such terminates in the morning. Hence not all knowledge of a thing in its nature can be called evening knowledge, but only that which is referred to the glory of the Creator. Thus the knowledge which the demons have of things cannot, strictly speaking, be called either morning or evening knowledge: because morning and

evening in reference to the angelic knowledge are not to be likened to it on all points but only in the point of beginning and end.

Reply to the Fifteenth Objection. Although created in grace, the angel was not beatified from the very beginning of his creation, nor did he see God's Word in his essence: wherefore neither had he morning knowledge of himself, which signifies knowledge of a thing through the species of the Word. But at first he had evening knowledge of himself inasmuch as he knew himself in himself naturally, for this reason that in everyone natural knowledge precedes supernatural knowledge, as being the latter's foundation, and an angel's knowledge naturally follows his being in his own nature: so that when he was first created he had not morning but evening knowledge of himself. This knowledge he referred to the praise of the Word and by so doing he merited morning knowledge. It is significant then that the first day is stated to have had only an evening and not a morning, which evening passed into morning: because the spiritual creature which, we are told, was made on the first day, knew itself as soon as it was made. This was evening knowledge, and by referring it to the praise of the Word, it merited the morning knowledge of the next work. For not every knowledge of a thing in its nature can be called evening knowledge but only that which is referred to the praise of the Creator: since evening recedes and ends with the morning. Hence the knowledge which the demons acquire by themselves about things is neither morning nor evening knowledge: but this can only be said of the knowledge gratuitously bestowed on the good angels. Accordingly the knowledge of things in their respective natures, if it be referred to the praise of the Word, is always evening knowledge: nor does the fact that it is so referred make it morning knowledge, but it makes it terminate therein, and by so doing the angel merits to receive morning knowledge. And just as the first day which signifies the formation and knowledge of the spiritual creature in its own nature, has only an evening, so too the seventh day has only a morning in that it signifies the contemplation of God which being faultless never wanes, and which corresponds to the angels' knowledge in reference to God's rest in himself, while to rest in God is the enlightenment and sanctification of everything. For in that God ceased to fashion new creatures he is said to have completed his work and to have rested in himself from his works. And just as God rests in himself alone, and is happy in the enjoyment of himself, even so we are made happy by enjoying him alone, and thus he makes us to rest in him both from his works and from our own. Accordingly the first day which corresponds to the knowledge which the spiritual creature enlightened by the light of grace had concerning itself, has only an evening: whereas the seventh day which corresponds to the angelic knowledge in reference to

God's rest and fruition in himself has only a morning, because in God there is no darkness. For God is stated to have rested on the seventh day inasmuch as he revealed to the angels his own rest whereby he rested in himself from the things he had made. It is the knowledge of this rest that Augustine (Dial. lxv, qu. 26) calls day. And since the creature's rest whereby it stands firm in God, has no end, in like manner God's rest whereby he rests in himself from the things he has made, in that he needs them not, has no end, for he will never need them: hence it is that the seventh day which corresponds to that rest has not an evening but a morning; whereas the other days which correspond to the angelic knowledge in reference to things, have both morning and evening, as already stated.

Reply to the Sixteenth Objection. As we have already explained, it is possible to know a thing already made as something yet to be made, if it be considered in the causes whence it issues: and thus the angels received knowledge in the Word of things to be made, for the Word is the supreme art of things. Because all knowledge of a thing in the Word, otherwise morning knowledge, is said to have for its object the thing as yet to be made, whether or not it be already made; since yet to be made indicates not time but the issue of the creature from the Creator, as stated above (ad 14). Wherefore though the corporeal creature was made at the same time as the spiritual nature, the angel is said by morning knowledge to know in the Word the thing as something yet to be made. Why the first day had no morning but only evening has been explained in the previous Reply.

Reply to the Seventeenth Objection. The spiritual creature does not derive his knowledge from things: he understands them naturally by means of innate or concreated species. Now the species in an angel's mind do not equally refer to the present and the future. Present things have actually a likeness to the forms in the angelic mind, so that by those forms the present can be known: whereas future things are not yet actually like those forms, so that by those forms the future cannot be known, since knowledge is effected by an actual assimilation of the known to the knower. Wherefore, as an angel does not know the future as such, he needs the presence of things in order that by the forms impressed on him he may know things in their respective natures: because before these latter are made, they are not assimilated to those forms. Moreover evening and morning knowledge are differentiated on the part not of the thing known but of the medium of knowledge. Morning knowledge results from an uncreated medium that transcends the nature both of the knower and of the thing known: and for this reason knowledge of things through the species of the Word is called morning whether the things be

already made or remain yet to be made: whereas evening knowledge is effected by means of a created medium that is proportionate both to the knower and to the thing known, whether the latter be already made or remain yet to be made.

Reply to the Eighteenth Objection. Although the angel has being in the Word before he has being in his own nature, nevertheless seeing that knowledge presupposes the existence .of the knower, he could not know himself before he existed. Now his knowledge of himself in his own nature is natural to him, whereas his knowledge of the Word is supernatural. Hence it behoved. him to know himself first in his own nature, before knowing himself in the Word: because in everyone natural knowledge precedes supernatural as its foundation. Other things, however, by his morning knowledge he knew in the Word by a priority of the natural order before knowing them in their respective natures by his evening knowledge: so that in respect of the subsequent works morning preceded evening, as already stated.

Reply to the Nineteenth Objection. As one complete science includes various particular sciences, whereby various conclusions are known, so also the one angelic knowledge which is a kind of whole comprises morning and evening knowledge as its parts, even as morning and evening are parts of the day, albeit disparate. Because things that are mutually disparate if ordered to each other can constitute one whole: thus matter and form which are disparate, constitute one composite; and again flesh, bones and sinews are parts of one composite body. Now the divine essence whereby things are known in the Word by morning knowledge is the prototype of all the concreated forms in the angelic mind, seeing that these derive from it as from their exemplar, and through them things are known in their own nature by evening knowledge: even as the angel's essence is the type whereby he understands the being which he knows; yet it is not a. perfect type, for which reason he needs other superadded forms. Consequently when an angel sees God in his essence, as also himself and other things by means of concreated species, in a way of speaking he understands one thing: thus because light is the reason for seeing colour, therefore when the eye sees both light and colour it sees in a manner of speaking one visible thing. And although these operations are distinct in reality, seeing that the operation whereby he sees God is everlasting and is measured by participated eternity, and the operation whereby he understands himself is everlasting and is measured by eviternity, while the operations whereby he understands other things by innate species is not everlasting but one succeeds the other, nevertheless since one is ordered to the other, and one is the formal reason as it were of the other, they are so to speak one thing: because where one thing is

on account of another there is but one (Top. iii, 2), so that when several operations are mutually ordered the one to the other, they can be simultaneous and constitute one whole.

Reply to the Twentieth Objection. Whereas the intellect is the abode of intelligible species, it follows that the science of setting in order the intelligible species, in other words the intellect's skill and ability in using those species must remain after death, even as the intellect itself which is the abode of those species. On the other hand the manner in which it actually uses them in the present state of life, namely by turning to phantasms which dwell in the sensible powers, will not remain after death: because seeing that the sensible powers will be destroyed, the soul will be unable either by the species acquired in this life, or by the species acquired by it in its state of separation, to understand by turning t o phantasms; but it will be able to do so in a manner befitting the mode of being that it will have in likeness to the angels. Hence knowledge will be destroyed not as to the habit, nor as to the substance of the cognitive act that takes its species from the species of the object, but as to the manner of knowing, which will not be by conversion to the phantasms; and this is the meaning intended by the Apostle.

Reply to the Twenty-first Objection. The light caused in the air by the sun and that produced by a candle are of the same kind, and seeing that two forms of the same kind cannot coexist in a perfect state in the same subject, it follows that sun and candle together produce one light in the air. Now the divine essence whereby things are known in the Word differs in kind from the species whereby an angel knows a thing in its nature: wherefore the comparison fails. For when perfection is come the opposite imperfection is made void: thus on the advent of the vision of God, faith which is of things unseen is made void. But the imperfection of evening knowledge is not opposed to the perfection of morning knowledge, since knowledge of a thing in itself is not, opposed to knowledge of it in its cause: nor again does it involve a contradiction that a thing be known through two mediums one of which is more perfect than the other: even so we may hold the same conclusion by a demonstration and a probable medium. In like manner the same thing may be known by an angel in the uncreated Word and through an innate species; since the one is not opposed, in fact rather is it a material disposition, to the other. Now perfection by its advent removes the opposite imperfection. But the imperfection of nature is not opposed to the perfection of heavenly bliss, in fact it underlies it, just as the imperfection of potentiality underlies the perfection of form: and the form removes not potentiality but the privation to which it is opposed. In like manner the imperfection of natural knowledge is not opposed to the perfection of the beatific

knowledge but underlies it as a material disposition. Hence the angel can know things by a created medium in their own nature; and this is 'evening' and natural knowledge; and at the same time by the essence of the Word, which is beatific and' morning ' knowledge." And these two knowledges do not hinder each other, since the one is ordered to the other, and is by way of a material disposition to the other.

Reply to the Twenty-second Objection. Augustine (Super Gen. v, 12, 14) holds that at the very beginning of creation certain things specifically distinct were produced in their respective, natures, such as the four elements produced from nothing, as well as the heavenly bodies and spiritual substances: for this kind of production requires no matter either out of which or in which a thing is made. Also that other things are stated to have been created in their seed-forms, for example animals, plants and men, and that these were all subsequently produced in their respective natures in that work by which God after the six days attends to nature previously established, of which work it is said (Jo. v, 17): My Father worketh until now. Moreover he holds that in the production and distinction of things we should see an order not of time but of nature: inasmuch as all the works of the six days were wrought in the one instant of time either actually, or potentially in their seed-forms, in that afterwards they could be made from pre-existent matter either by the Word, or by the active forces with which the creature was endowed in its creation. Wherefore in regard to the first man's soul which, he suggests without asserting it, was created actually at the same time as the angels, he does not hold that it was created before the sixth day, although he holds that on the sixth day it was actually made, and the first man's body as to its seed-forms: for God endowed the earth with a passive potentiality so that by the active power of the Creator man's body could be formed therefrom. Accordingly the soul was actually made at the same time as the body was made in its passive potentiality to God's active power.—Or again, seeing that in truth according to Aristotle (De Anima ii), the soul is not a complete species in itself but is united to the body as the latter's form, and is naturally a part of human nature, we must infer that the first man's soul was not brought into actual existence before the formation of the body, but was created and infused into the body at the same time as the body was formed, even as Augustine holds (Super Gen. x, 17) with regard to other souls. For God produced the first things in their perfect natural state, according as the species of each one required. Now the rational soul being a part of human nature has not its natural perfection except as united to the body. Hence it naturally has its being in the body, and existence outside the body is non-natural to it: so that it was unfitting for the soul to be created without the body.

If then we adopt the opinion of Augustine on the works of the six days, it may be said that as in those six days the body of the first man was not actually formed and produced, but only potentially in its seed-forms: even so his soul was not produced then actually and in itself, but in its generic likeness; and thus preceded the body during those six days not actually and in itself, but in respect of a certain generic likeness, inasmuch as it has an intellectual nature in common with the angels. Afterwards however, in the work whereby God attends to the creature already produced, the soul was actually created at the same time as the body was formed.

The Reply to the Twenty-third Objection is clear from what has been said. The human body was not brought into actual existence in those six days, as neither were the bodies of other animals, but only in the shape of seed-forms, since God in creating the elements, planted in them certain forces or seeds, so that either by the power of God, or by the influence of the stars or by seminal propagation animals might be produced. Accordingly those things that were actually produced in those six days were created not by degrees but at the same time, while the others were brought into existence as seed-forms in their like.

Reply to the Twenty-fourth Objection. As we have already said in the Reply to the Sixteenth Objection, knowledge of things by innate species that are proportionate to things is called 'evening' knowledge and is of things as subsisting in their respective nature, whether already made or yet to be made. And although those species are related equally to the present or future, the things themselves that are present or future are not equally related to the species because present things are actually assimilated to the species and thus can be actually known thereby; whereas future things are not actually assimilated to them. Therefore it does not follow that they can be known by them. And evening knowledge which is of things in their respective natures is not so called because the angels take from things the species whereby they understand them, but because by the species received at their creation they understand things as subsisting in their respective nature.

Reply to the Twenty-fifth Objection. In Augustine's opinion (Super Gen. ii, 8) the angels from the very beginning saw the things to be made by the Word. The things which, we are told, were made in the works of the six days were all made at the same time: wherefore those six days were all from the very outset of the creation, and consequently the good angels must have known the Word and creatures in the Word from the very beginning. Creatures have a threefold being as already stated. First in the divine art which is the Word: this is signified when it is said: God said ? Let... be made, i.e. He begot the Word in whom such and such a work was before it could be made. Secondly, they have being in the angelic

intelligence, and this is signified in the words, It was so done, to wit by the outpouring of the Word. Thirdly they have being in themselves and in their respective natures. In like manner the angel has a threefold knowledge of things: of things as existing in the Word, as existing in his own mind, and as existing in their respective natures. Again the angel has a twofold knowledge of the Word: a natural know ledge whereby he knows the Word by his likeness shining forth in his (the angel's) nature, wherein consists his natural beatitude, and which he can obtain by his natural powers: and a supernatural and beatific knowledge whereby he knows the Word in his (the Word's) essence, and in this his supernatural beatitude consists, which surpasses his natural powers.

By either of these the good angel knows things or creatures in the Word: by his natural knowledge, however, he knows things in the Word imperfectly: whereas by his beatific knowledge he knows things in the Word with greater fullness and perfection.

The first knowledge of things in the Word was received by the angel at the instant of his creation, wherefore it is stated in De Eccl. Dogmat. that "the angels who persevered in the happy state wherein they were created, possess the good they have, not by nature but by grace." Again Augustine (De Fide ad Pet. iii) says: "The angelic spirits received from above the gift of eternity and beatitude when they were created in their spiritual nature." Yet they were not thereby beatified simply, seeing that they were capable of greater perfection, but in a restricted sense, i.e. in relation to the time being. Thus the Philosopher (I Ethic. x) says that some are happy in this life, not simply, but as men. The second or beatific knowledge was bestowed on the angels not from the beginning of their creation, since they were not created in a state of perfect beatitude, but from the moment they were beatified by perfect conversion to the good. Accordingly all these six classes of things were created at the same time together with the angels, and in the same instant the angel by natural knowledge knew in the Word whatsoever afterwards he knew in the Word more fully by supernatural knowledge, which the angels received immediately on their referring their natural self-knowledge to the praise of the Word: and this same natural knowledge being measured by eviternity, is always coexistent with their supernatural knowledge of the Word, and with their knowledge through innate species, of creatures in their respective natures. Hence these three cognitions are co-existent, nor does one properly speaking follow the other: although, the knowledge of things in the Word, be they already made or yet to be made, is called morning knowledge: while the knowledge of things through a created medium in their own nature, be they present or future, is called evening knowledge.

Reply to the Twenty-sixth Objection. It is not possible that an angel see the Word or divine essence as the type of things to be made, without seeing it as the end of the Blessed and the object of beatitude c since the divine essence in itself is the object of beatitude and the end of the Blessed. For it is not possible to see the divine essence as the type of things to be made without seeing it in itself; wherefore the whole argument is granted.

Reply to the Twenty-seventh Objection. Some with the object of distinguishing between prophetic and beatific knowledge; contended that the prophets see the divine essence itself which they call the mirror of eternity, not however in the way in which it is the object of the Blessed and the end of beatitude, but as the type of things to be done, inasmuch as it contains the types of future events, as stated in the argument. But this is impossible, since God in his very essence is the object of beatitude and the end of the Blessed, according to the saying of Augustine (Conf. v, 4): Happy whoso knoweth thee, though he know not these, i.e. creatures. Now it is not possible, to see the types of creatures in the very essence of God without seeing it also, both because the divine essence is the type of all things that are made (the ideal type of the thing to be made adding nothing to the divine essence save only a relationship to the creature); and because knowledge of a thing in itself (and such is the knowledge of God as the object of heavenly bliss) precedes the knowledge of that thing as related to something else (and such is the knowledge of God as containing the types of things). Wherefore it is impossible for prophets to see God as containing the types of creatures yet not as the object of heavenly bliss. And since they do not see the divine essence as the object of heavenly bliss (both because vision does away with prophecy (1 Cor. xiii, 9, 10) and because the beatific vision denotes knowledge of God not as distant but as near, since he is seen face to face), it follows that prophets do not see the essence of God as the type of future events, nor do they see things in the Word as the angels did by morning knowledge. For the prophetic vision is not the vision of the very essence of God, nor do they see in the divine essence Itself the things that they do see, as the angels did: but they see them in certain images according as they are enlightened by the divine light as Dionysius says (Cad. Hier. iv). These images illumined by the divine light have more of the nature of a mirror than the divine essence, inasmuch as in a mirror are formed images from other things, and this cannot be said of God. Yet the prophet's mind thus enlightened may be called a mirror in so far as a likeness of the truth of the divine foreknowledge is reflected therein, and for this reason it is called the mirror of eternity as reflecting by means of those images the fore-knowledge of God who in his eternity sees all things as present

before him. Hence the prophet's knowledge bears a greater resemblance to the angel's evening than to his morning knowledge: since the morning knowledge is effected through an uncreated medium, and the prophet's through a created medium, that is by species impressed on him or illumined by the divine light, as stated above.

Reply to the Twenty-eighth Objection. In Augustine's opinion the words, Let the earth bring forth the green herb do not signify that plants were actually produced then in their own nature, but that the earth then received certain forces of production to be brought into action in the work of propagation: so that we may understand that the earth did then bring forth the green herb and the fruit-tree yielding fruit in the sense that then it was made capable of bringing them forth. This is confirmed by the authority of Scripture (Gen. ii, 4, 5) where we read: These are the generations of the heaven and the earth when they were created in the day that the Lord God made the heaven and the earth, and every plant of the field before it sprung up in the earth, and every herb of the ground before it grew. Whence two conclusions are to be inferred. First, that all the works of the six days were created on the day when God made heaven and earth and every plant of the field, so that the plants, which are stated to have been made on the third day were produced at the same time as heaven and earth were created by God. Secondly, that the plants were brought forth then, not into actual existence, but only in certain seed-forms, inasmuch as the earth was enabled to produce them. This is signified when it is stated that God brought forth every plant of the field before it actually sprung up in the earth by the work of administration, and every herb of the ground before it grew. Accordingly before they actually grew above the earth they were produced causally in the earth.

It is also confirmed by the following argument. In those first days God produced the creature in its cause, in its origin, or mi actual existence, by a work from which he rested subsequently, and yet afterwards in the administration of things which he had made, he continues to work even until now in the work of propagation. Now the production of plants from the earth into actual existence belongs to the work of propagation, since the powers of the heavenly body as father, and of the earth as mother suffice for their production. Hence the plants were not actually produced on the third day but only in their causes: and after the six days they were brought into actual existence in their respective species and natures by the work of government. Consequently before the plants were produced causally, nothing was produced, but they were produced together with the heaven and the earth. In like manner the fishes, birds and animals were produced in those six days causally and not actually.

Reply to the Twenty-ninth Objection. It belongs to the wisdom of an artificer whose works, like God's, are all perfect, to make neither the whole separate from its chief part, nor the parts separate from the whole: since neither the whole separate from the chief part, or the parts separate from the whole have perfect being. Since then the angels in their various species, together with the heavenly bodies and the four elements are the chief parts constituting the one universe, inasmuch as they are mutually ordered to one another and of service the one to the other; it follows that it belongs to God's wisdom to produce the whole universe, together with all its parts at the same time and not by degrees. The reason whereof is that of one whole together with all its parts there should be but one production, and that to produce the one before the other is a mark of weakness in the agent. Now God has infinite power without any weakness, and the universe is his principal effect. Wherefore he created by one single productive act the whole universe together with all its principal parts. And although in the production of the universe no order of time was observed, the order of nature and origin was observed. For according to Augustine the work of creation preceded the work of distinction in the order of nature but not of time; likewise the work of distinction preceded the work of adornment in the order of nature. The work of creation consisted in the making of heaven and earth: and by the heaven we are to understand the production of the spiritual nature in a formless condition: and by the earth, —the formless matter of corporeal beings. These two, as Augustine says (Conf. xii, 8), being outside time, considered in their essence are not subject to the alternations of time: wherefore the creation of both is described as taking place before all days. Not that this formless condition preceded formation by a priority of time, but only in the order of nature and origin, as sound precedes song. Again in his opinion, one formation does not precede another in point of duration, but only in the order of nature. According to this order we must needs give the first place to the formation of the highest spiritual nature, signified in the making of light on the first day, inasmuch as the spiritual nature surpasses the corporeal in dignity and eminence, wherefore it behoved it to be formed first: and it is formed by being enlightened, so as to adhere to the Word of God. Now just as in the natural order spiritual and divine light surpasses the corporeal nature in dignity and eminence, so also do the higher bodies surpass the lower. Hence on the second day mention is made of the formation of the higher bodies, when it is said, Let a firmament be made, whereby it is signified that a heavenly form was bestowed on formless matter which existed already not in point of time but in the order of origin only. The third place is given to the impression of the elemental forms on formless matter, existing already by a priority not

of time but of origin and nature. Hence by the words, Let the waters be gathered together and let the dry land appear, we are to understand that corporeal matter received the substantial form of water so that it was enabled to carry out that movement, as also the substantial form of earth so that it became visible as dry land: because water glides and flows away, whereas the earth abides (Gen. ad lit. ii, ii). Moreover under the name of wker, according to Augustine, we are to understand that the other higher elements also were formed.

In the following three days corporeal nature is stated to have been adorned. It behoved the parts of the world to be first in the order of nature formed and distinguished and afterwards each part to be adorned by being filled with their respective occupants. On the first day, as stated, the spiritual nature was formed and distinguished,; on the second the heavenly bodies were formed and distinguished, and on the fourth adorned; on the third day the lower bodies', namely, air, water and earth were formed and distinguished: of which the air and water as being of greater dignity were adorned on the fifth day; and the earth, being the lowest body, was adorned on the sixth day. Thus the perfection of the divine works corresponds to the perfection of the number six which is the sum and product of its aliquot parts, one, two and three: in that one day was deputed to the formation and distinction of the spiritual creature: two days to the formation and distinction of the corporeal nature, and three to its adornment (thus 1+2+3=6: 6x1=6: 2x3=6 and 3x2=6). Since then six is the first perfect number, it fittingly denotes the perfection of things and of the divine works. Accordingly there is nothing to show that the order of the divine works was one of time and not of nature.

Reply to the Thirtieth Objection. The luminaries were produced in actual and not virtual existence like the plants: thus the firmament has no power productive of luminaries, as the earth has enabling it to bring forth plants. Hence Scripture does not say: Let the firmament produce lights, as it says: Let the earth bring forth the green herb, i.e. let it have the power to produce them. Wherefore the luminaries actually existed before the plants did, although the latter were produced virtually and in their causes before the luminaries were brought into actual existence. Moreover it has been stated that the order of production preceded in the order of nature the work of adornment; and the luminaries belong to the adornment of the heavens, while the plants, especially as regards their virtual existence, do not belong to the adornment of the earth, but rather to its perfection. For seemingly only such things belong to the perfection of the heavens and the earth as are intrinsic to the heavens and earth; while adornment is one of those things that are distinct from them: even so a man is perfected by his proper parts and forms, but is adorned by his clothes or

something of the kind. Now things become mutually distinct especially by local movement whereby they are separated the one from the other. . Hence the work of adornment comprises in a special way the production of those things that are endowed with movement whether in the heavens or on the earth. According to Ptolemy the luminaries are not fixed in the heavens but have a movement independent of that of the spheres, while in the opinion of Aristotle, the stars are fixed to the spheres; and really do not move except with the movement of the spheres: nevertheless the movements of the luminaries and stars is perceptible to the senses whereas that of the spheres is not. Moses coming down to the level of an unlettered people, described things as they appear, by saying that the luminaries are an adornment of the heavens.—Plants are not part of the earth's adornment, only the animals are: because a thing belongs to the adornment of the place wherein it has real or apparent movement, and not where it remains motionless; and the plants cling to the earth by their roots, so that they are not part of its adornment but form part of its perfection. As to the stars although they have no movement of themselves, they have an accidental and apparent movement; while the plants have no movement at all. Consequently in the order of nature it. behoved the plants which belong to the intrinsic perfection of part of the universe to be produced before the luminaries which belong to the adornment of the heavens.

Reply to the Thirty-first Objection. According to Augustine (Super Gen. contra Manich. i, 5, 7) the earth and water mentioned at the beginning before the creation of the firmament do not signify the elements of earth and water, but primal matter devoid of all forms and species. Moses, seeing that he was addressing an unlettered people could not mention primal matter, except under the guise of things known to them and most akin to a formless condition through having more matter and less form. For this reason, he expresses it by combining a twofold comparison, and instead of calling it earth only or water only, he calls it earth and water, lest if he mentioned only one of these, it might be thought that primal matter was really that and nothing else. ' Yet it bears a certain likeness to earth, inasmuch as it supports and underlies forms as the earth supports plants and other things. Again earth of all the elements has the least specification, being more solid and allied to matter, and less formal than the others. It bears also this likeness to water, that it has a natural aptitude for receiving various forms: because humidity which is becoming to water renders things impressionable and easy to fix. Accordingly the earth is said to be void and empty or invisible and incomposite, because matter is known by its form: so that considered in itself, it is said to be invisible, i.e. unknowable, and void inasmuch as the form is the end for

which matter craves (because a thing is said to be void when it fails to obtain its end): or it is called void in comparison with the composite wherein it subsists, because a void is opposed to firmness and solidity. It is said to be incomposite, because it cannot subsist outside a composite, and lacks the beauty of actual existence. It is said to be empty because its potentiality is filled by the form: hence Plato (Tim.) identified matter with place, inasmuch as the receptivity of matter is somewhat like to the receptivity of place, in that while the same matter remains, divers forms succeed one another, just as divers bodies succeed one another in one place. Hence terms that are predicated of place are by comparison predicated of matter, so that matter is said to be empty because it lacks the form which fills the capacity and potentiality of matter. Thus, then, formless primal matter in the order of nature and origin preceded the formation of the firmament, and the latter in the order of nature preceded the earth and water mentioned on the third day, as stated above.

Reply to the Thirty-second Objection. Augustine (De Civ. Dei xi, 33) holds that it was not fitting for Moses to omit the production of the spiritual creature: and so he contends that in the words, In the beginning God created, heaven and earth, heaven signifies the spiritual creature as yet unformed, and earth, formless corporeal matter. And seeing that the spiritual nature is more worthy than the corporeal, it behoved it to receive its formation first. Accordingly the formation of the spiritual nature is signified in the creation of light which denotes spiritual light; because the formation of a spiritual nature consists in its being enlightened so as to adhere to the Word of God, not indeed by perfect glory in which it was not created, but by that which is conferred with the light of grace in which it was created: and this spiritual light preceded the firmament in the order of nature.

But in the opinion of other holy men the light created on the first day was corporeal, and was produced in the heaven created on the first day together with the substance of the sun as regards the common nature of light, while on the fourth day it received definite powers for the production of definite effects.

Reply to the Thirty-third Objection. The order of the production of these animals, since they belong to the adornment of the parts of the universe, depends on the order of the parts they adorn rather than on their own excellence. Now air and water which are adorned by fishes and birds as being more worthy in the order of nature precede the earth which is adorned by the animals that walk on its surface: wherefore it behoved the production of flying creatures and of fishes or swimming creatures to precede that of the creatures that walk.—It might also be said that in the

process of generation perfection follows imperfection, and is ordered in such wise that the more imperfect things are produced first in the order of nature: because this process requires that the more perfect a thing is and the greater its likeness to the active cause, the later its production in point of time, although in the order of nature and dignity it takes precedence. For this reason since man is the most perfect of all animals, it behoved him to be made after all the others and not immediately after the heavenly bodies, which are not reckoned in relation to the lower bodies in the order of generation, since they have no matter in common with them, but one that is altogether disparate.

Reply to the Thirty-fourth Objection. Birds and fishes as regards the matter from which they are produced have more in common with each other than with terrestrial animals. Fishes and birds are said to be produced from the waters: the former from the more solid parts, the latter from the more subtle portion that was resolved into vapour so as to be a mean between air and water: hence the birds arose into the air, while the fishes sank into the deep. Now animals are assigned to various days or to one day according as their bodies are produced from different matters or from the same matter. Since then fishes and birds are said to be produced from the waters inasmuch as, considering their respective temperaments in comparison with the temperament peculiar to the common genus, they have more water in their composition than other animals have, whereas other animals are said to have been produced from the earth, hence it is that one day is assigned to the production of fishes and birds, and another day to the production of the terrestrial animals. Moreover the production of animals is related solely with respect to their being intended for the adornment of parts of the world: wherefore the days on which the animals were produced are distinguished solely with respect to their likeness or difference in the point of adorning some part of the world. As to fire and air seeing that the common people do not regard them as parts of the world, Moses does not mention them expressly but comprises them with the intermediate element namely water, especially as regards the lower parts of the air. Consequently one day is assigned to the birds and fishes which adorn the water and the air as to its lower part which is akin to water: while one other day is assigned to all the terrestrial animals.

If, however, preference be given to the opinion of Gregory and others, the arguments against this view must now be dealt with. These authors hold that between the days in question there was a succession of time, and that things were produced by degrees, so that when heaven and earth were created, there was as yet no light, nor was the firmament

formed, nor were the waters removed from the face of the earth, nor the heavenly lights produced.

1. On the day when God created heaven and earth, namely the heavenly bodies and the four elements with their substantial forms, he also created every plant of the field, not actually or before it sprang up from the earth, but potentially so that afterwards on the third day it was produced into actual existence.

2. According to Gregory (Moral. xxxii, 9) when God created the angel, he created man also, not actually or in himself, but potentially or in his likeness, in so far as he is like the angels in regard to his intellect. Afterwards on the sixth day man was produced actually in himself.

3. The disposition of a thing that is already complete is not the, same as its disposition while yet in the making: wherefore although the nature of a perfect and complete world requires that all the essential parts of the universe exist together, it could be otherwise when the world was as yet in its beginning: thus in a complete man there cannot be a heart without his other parts, yet in the formation of the embryo the heart is fashioned before any other part. It may also be replied that in this beginning of things the heavenly bodies and all the elements with their substantial forms were produced together with the angels, all of which are the principal parts of the universe; and that on the following days, something was done in the nature already created, and pertaining to the perfection and adornment of the parts already produced.

4. Although the Greek doctors maintained that the spiritual creature was created before the corporeal, the Latin doctors held that the angels were created at the same time as the corporeal nature, so as to ensure the simultaneous production of the universe in respect of its principle parts. For seeing that corporeal creatures are one in created matter, and that the matter of corporeal creatures was created at the same time as the angels, it may be said that all things were in a sense created at the same time either actually or potentially. Now angels have not matter in common with the corporeal creature: wherefore when the angels were created, corporeal nature would nowise have been created, and consequently neither the universe: and so it is reasonable that they should be created together with the corporeal nature. Accordingly all corporeal things were created at the same time, not actually but in respect of matter in some way formless; and afterwards by degrees they were brought into actual existence by the distinction and adornment of the already existing creature.

5. Even as a creature has not being of itself so neither has it perfection otherwise than from God: so in order to indicate that the creature has being from God and not of itself, it was his will that it should come into

existence after non-existence: and in order to indicate that the creature has not perfection of itself, it was God's will that it should be at first imperfect, and afterwards by degrees be perfected by the work of distinction and adornment. It may also be replied that it behoved the creation of things to show forth not only the might of God's power but also the order of his wisdom, so that things having precedence in nature have priority of production: wherefore it was not due to inability on the part of God as though he needed time for his works, that all things were not produced, distinguished and adorned at the same time, the reason of all this being that the order of wisdom might be observed in the production of things. Hence it was fitting that different days should be assigned to the different states of the world. After the work of creation the following work in every case added a new state of perfection to the world: wherefore in order to indicate this perfection and newness of state, it was God's will that one day should correspond to each distinction and adornment, and not because he was weak or tired.

6. The light which, we are told, was made on the first day was the light of the sun, according to Gregory and Dionysius, which, together with the substance of the luminaries, which is the subject of that light, was produced on the first day as regards the common nature of light. On the fourth day, the luminaries were endowed with a definite power for the production of definite effects: thu's we observe that the rays of the sun have a different effect from those of the moon, and so forth. For this reason Dionysius (Div. Nom. iv) says that this light was the light of the sun, but as yet formless as regards that which was the sun's substance, and was endowed with an illuminating power in a general way: and that afterwards it was formed on the fourth day, not indeed with a substantial form, since it has that on the first day, but as regards certain accidental additions by receiving definite powers for the production of definite effects. Accordingly when this light was produced, the light was divided from the darkness in a triple respect. First in respect of its cause, since the cause of light was the sun's substance, while the cause of darkness was the opaqueness of the earth. Secondly in respect of place, since there was light in one hemisphere and darkness in the other. Thirdly, in respect of time, since in the one hemisphere there was light at one time, and darkness at another. This is indicated in the words of Genesis i, 5, He called the light day and the darkness night. Hence that light neither covered the earth on all sides, since in one hemisphere there was light, and darkness in the other: nor was there always light on one side and darkness on the other, but in the same hemisphere there was day at one time and darkness at another.

7. The heaven has a twofold movement. One is the diurnal movement which is common to the whole heaven and causes day and night. This movement would seem to have been produced on the first day, when the formless substance of the sun and other luminaries was produced. The other is its own peculiar movement, which differs in the various heavenly bodies, whose movements bring about the differences of days, months and years. On the first day was produced the common division of time into day and night by the diurnal movement which is common to the whole heaven, and may be said to have begun on the first day. Wherefore on the first day mention is made only of the distinction of day and night produced by the diurnal movement common to all the heavens. On the fourth day was made the distinction as regards the difference of days and seasons, in that one day is warmer than another, one season warmer than another, and one year warmer than another: all of which result from the special and proper movements of the stars, which movements may be understood to have commenced on the fourth day. Hence it is that on the fourth day mention is made (ibid. 14) of the difference between days, seasons and years: And let them be for seasons and for days and for years: and this difference results from their respective movements. Accordingly those first three days that preceded the formation of the luminaries were of the same kind as the days that are now regulated by the sun as regards the common division of time into day and night resulting from the diurnal movement common to the whole heaven, but not as regards the special differences of days resulting from those proper movements.

8. Some say that the light stated to be created on the first day was a luminous cloud, which subsequently when the sun was made, was resolved into the surrounding matter. But this is not likely, seeing that in the beginning of Genesis Scripture relates the establishment of nature in that condition wherein it was to remain, so that it should not be said that anything was made which after a little while ceased to exist. Hence others say that this luminous cloud still exists but united to the sun in such a manner that it cannot be distinguished from it. But in this case this cloud would be superfluous, whereas nothing in God's works is void of purpose or superfluous. Wherefore yet others say that the body of the sun was formed from this cloud. But this again is inadmissible, if we suppose the solar body not to be composed of the four elements but actually incorruptible: since in that case its matter is not susceptive of different forms. Consequently we have to say with Dionysius (Div. Nom. iv) that this light was the light of the sun, of a formless sun however, in respect of what was already the substance of the sun: and that it had an illuminating power in a general way, and that on the fourth day it received a special

definite power for the production of its peculiar and particular effects. And thus day and night resulted 'from the circular movement whereby this light approached and receded. Nor is it unlikely that the substances of the spheres which by their common diurnal movement caused this light to revolve, existed from the very beginning, and that subsequently they received certain powers in the works of distinction and adornment.

9. The production of light signifies that the property of ,luminosity and transparency which is reducible to the genus of light was then bestowed on all luminous and diaphanous bodies. And since the sun is the principle and source of light, by illuminating both higher and lower bodies, therefore Dionysius by the light in question understands the formless light of the sun, which by the common diurnal movement divided the day from the night, even as it does now.

10. And thus the tenth argument is solved, since that light was not a cloud in its very substance that afterwards ceased to be. It might however be called a cloud as resembling one in respect of a property, in that as a luminous cloud receives from the sun a light that is less bright than its source, even so in those first three days the substance of the sun had an imperfect and as it were formless light which was afterwards perfected on the fourth day: wherefore the substance of the sun was then luminous, since from the moment in which it was created it had its substantial form: yet the sun is stated to have been formed from it on the fourth day, not in substance, but by the addition of a new power, just as a man from being ignorant of music becomes musical not in substance but in capacity.

MESSAGE TO THE PONTIFICAL ACADEMY OF SCIENCES:
ON EVOLUTION
Pope John Paul II

Magisterium Is Concerned with Question of Evolution for It Involves Conception of Man
Message delivered to the Pontifical Academy of Sciences 22 October 1996

To the members of the Pontifical Academy of Sciences, in plenary assembly:

It is with great pleasure that I send my cordial greetings to you, Mr. President, and to all of you who constitute the Pontifical Academy of Sciences, on the occasion of your plenary assembly. I send my particular best wishes to the new members of the Academy, who come to take part in your work for the first time. I also wish to recall the members who have died in the course of the past year; I entrust them to the Maker of all life.

1. In celebrating the 60th anniversary of the re-foundation of the Academy, it gives me pleasure to recall the intentions of my predecessor, Pius XI, who wished to bring together around him a chosen group of scholars who could, working with complete freedom, inform the Holy See about the developments in scientific research and thus provide aid for reflections.

To those whom he enjoyed calling the Scientific Senate of the Church, he asked simply this: that they serve the truth. That is the same invitation which I renew today, with the certainty that we can all draw profit from "the fruitfulness of frank dialogue between the Church and science." (Discourse to the Academy of Sciences, October 28, 1986, #1)

2. I am delighted with the first theme which you have chosen: the origin of life and evolution—an essential theme of lively interest to the Church, since Revelation contains some of its own teachings concerning the nature and origins of man. How should the conclusions reached by the diverse scientific disciplines be brought together with those contained in the message of Revelation? And if at first glance these views seem to clash with each other, where should we look for a solution? We know that the truth cannot contradict the truth. (Leo XIII, Providentissimus Deus) However, in order better to understand historical reality, your research into the relationships between the Church and the scientific community between the 16th and 18th centuries will have a great deal of importance.

In the course of this plenary session, you will be undertaking a "reflection on science in the shadow of the third millennium," and beginning to determine the principal problems which the sciences face, which have an influence on the future of humanity. By your efforts, you will mark out the path toward solutions which will benefit all of the human community. In the domain of nature, both living and inanimate, the evolution of science and its applications gives rise to new inquiries. The Church will be better able to expand her work insofar as we understand the essential aspects of these new developments. Thus, following her specific mission, the Church will be able to offer the criteria by which we may discern the moral behavior to which all men are called, in view of their integral salvation.

3. Before offering a few more specific reflections on the theme of the origin of life and evolution, I would remind you that the magisterium of the Church has already made some pronouncements on these matters, within her own proper sphere of competence. I will cite two such interventions here.

In his encyclical Humani Generis (1950), my predecessor Pius XII has already affirmed that there is no conflict between evolution and the doctrine of the faith regarding man and his vocation, provided that we do not lose sight of certain fixed points.

For my part, when I received the participants in the plenary assembly of your Academy on October 31, 1992, I used the occasion—and the example of Gallileo—to draw attention to the necessity of using a rigorous hermeneutical approach in seeking a concrete interpretation of the inspired texts. It is important to set proper limits to the understanding of Scripture, excluding any unseasonable interpretations which would make it mean something which it is not intended to mean. In order to mark out the limits of their own proper fields, theologians and those working on the exegesis of the Scripture need to be well informed regarding the results of the latest scientific research.

4. Taking into account the scientific research of the era, and also the proper requirements of theology, the encyclical Humani Generis treated the doctrine of "evolutionism" as a serious hypothesis, worthy of investigation and serious study, alongside the opposite hypothesis. Pius XII added two methodological conditions for this study: one could not adopt this opinion as if it were a certain and demonstrable doctrine, and one could not totally set aside the teaching Revelation on the relevant

questions. He also set out the conditions on which this opinion would be compatible with the Christian faith—a point to which I shall return.

Today, more than a half-century after the appearance of that encyclical, some new findings lead us toward the recognition of evolution as more than an hypothesis.* In fact it is remarkable that this theory has had progressively greater influence on the spirit of researchers, following a series of discoveries in different scholarly disciplines. The convergence in the results of these independent studies—which was neither planned nor sought—constitutes in itself a significant argument in favor of the theory.

What is the significance of a theory such as this one? To open this question is to enter into the field of epistemology. A theory is a meta-scientific elaboration, which is distinct from, but in harmony with, the results of observation. With the help of such a theory a group of data and independent facts can be related to one another and interpreted in one comprehensive explanation. The theory proves its validity by the measure to which it can be verified. It is constantly being tested against the facts; when it can no longer explain these facts, it shows its limits and its lack of usefulness, and it must be revised.

Moreover, the elaboration of a theory such as that of evolution, while obedient to the need for consistency with the observed data, must also involve importing some ideas from the philosophy of nature.

And to tell the truth, rather than speaking about the theory of evolution, it is more accurate to speak of the theories of evolution. The use of the plural is required here—in part because of the diversity of explanations regarding the mechanism of evolution, and in part because of the diversity of philosophies involved. There are materialist and reductionist theories, as well as spiritualist theories. Here the final judgment is within the competence of philosophy and, beyond that, of theology.

5. The magisterium of the Church takes a direct interest in the question of evolution, because it touches on the conception of man, whom Revelation tells us is created in the image and likeness of God. The conciliar constitution Gaudium et Spes has given us a magnificent exposition of this doctrine, which is one of the essential elements of Christian thought. The Council recalled that "man is the only creature on earth that God wanted for its own sake." In other words, the human person cannot be subordinated as a means to an end, or as an instrument of either the species or the society; he has a value of his own. He is a person. By this

intelligence and his will, he is capable of entering into relationship, of communion, of solidarity, of the gift of himself to others like himself. St. Thomas observed that man's resemblance to God resides especially in his speculative intellect, because his relationship with the object of his knowledge is like God's relationship with his creation. (Summa Theologica I-II, q 3, a 5, ad 1) But even beyond that, man is called to enter into a loving relationship with God himself, a relationship which will find its full expression at the end of time, in eternity. Within the mystery of the risen Christ the full grandeur of this vocation is revealed to us. (Gaudium et Spes, 22) It is by virtue of his eternal soul that the whole person, including his body, possesses such great dignity. Pius XII underlined the essential point: if the origin of the human body comes through living matter which existed previously, the spiritual soul is created directly by God ("animas enim a Deo immediate creari catholica fides non retimere iubet"). (Humani Generis)

As a result, the theories of evolution which, because of the philosophies which inspire them, regard the spirit either as emerging from the forces of living matter, or as a simple epiphenomenon of that matter, are incompatible with the truth about man. They are therefore unable to serve as the basis for the dignity of the human person.

6. With man, we find ourselves facing a different ontological order—an ontological leap, we could say. But in posing such a great ontological discontinuity, are we not breaking up the physical continuity which seems to be the main line of research about evolution in the fields of physics and chemistry? An appreciation for the different methods used in different fields of scholarship allows us to bring together two points of view which at first might seem irreconcilable. The sciences of observation describe and measure, with ever greater precision, the many manifestations of life, and write them down along the time-line. The moment of passage into the spiritual realm is not something that can be observed in this way—although we can nevertheless discern, through experimental research, a series of very valuable signs of what is specifically human life. But the experience of metaphysical knowledge, of self-consciousness and self-awareness, of moral conscience, of liberty, or of aesthetic and religious experience—these must be analyzed through philosophical reflection, while theology seeks to clarify the ultimate meaning of the Creator's designs.

7. In closing, I would like to call to mind the Gospel truth which can shed a greater light on your researches into the origins and the development of

living matter. The Bible, in fact, bears an extraordinary message about life. It shows us life, as it characterizes the highest forms of existence, with a vision of wisdom. That vision guided me in writing the encyclical which I have consecrated to the respect for human life and which I have entitled precisely The Gospel of Life.

It is significant that in the Gospel of St. John, life refers to that divine light which Christ brings to us. We are called to enter into eternal life, which is to say the eternity of divine beatitude.

To set us on guard against the grave temptations which face us, our Lord cites the great words of Deuteronomy: "Man does not live by bread alone, but by every word that comes from the mouth of God." (Deut 8:3; Mt 4:4)

Even more, life is one of the most beautiful titles which the Bible gives to God; he is the living God.

With a full heart, I invoke upon all of you, and all to whom you are close, an abundance of divine blessings.

From the Vatican, October 22, 1996, John Paul II

EWTN Note on translation:
The English edition at first translated the French original as: "Today, more than a half-century after the appearance of that encyclical, some new findings lead us toward the recognition of more than one hypothesis within the theory of evolution." The L'Osservatore Romano English Edition subsequently amended the text to that given in the body of the message above, citing the translation of the other language editions as its reason. It should be noted that an hypothesis is the preliminary stage of the scientific method and the Pope's statement suggests nothing more than that science has progressed beyond that stage. This is certainly true with respect to cosmological evolution (the physical universe), whose science both Pius XII and John Paul II have praised, but not true in biology, about which the popes have generally issued cautions (as above and Humani Generis).

http://www.ewtn.com/library/PAPALDOC/JP961022.HTM

From *The Descent of Man*
Darwin

INTRODUCTION.

THE nature of the following work will be best understood by a brief account of how it came to be written. During many years I collected notes on the origin or descent of man, without any intention of publishing on the subject, but rather with the determination not to publish, as I thought that I should thus only add to the prejudices against my views. It seemed to me sufficient to indicate, in the first edition of my 'Origin of Species,' that by this work "light would be thrown on the origin of man and his history;" and this implies that man must be included with other organic beings in any general conclusion respecting his manner of appearance on this earth. Now the case wears a wholly different aspect. When a naturalist like Carl Vogt ventures to say in his address as President of the National Institution of Geneva (1869), "personne, en Europe au moins, n'ose plus soutenir la crèation indèpendante et de toutes pièces, des espèces," it is manifest that at least a large number of naturalists must admit that species are the modified descendants of other species; and this especially holds good with the younger and rising naturalists. The greater number accept the agency of natural selection; though some urge, whether with justice the future must decide, that I have greatly overrated its importance. Of the older and honoured chiefs in natural science, many unfortunately are still opposed to evolution in every form.

In consequence of the views now adopted by most naturalists, and which will ultimately, as in every other case, be followed by other men, I have been led to put together my notes, so as to see how far the general conclusions arrived at in my former works were applicable to man. This seemed all the more desirable as I had never deliberately applied these views to a species taken singly. When we confine our attention to any one form, we are deprived of the weighty arguments derived from the nature of the affinities which connect together whole groups of organisms—their geographical distribution in past and present times, and their geological succession. The homological structure, embryological development, and rudimentary organs of a species, whether it be man or any other animal, to which our attention may be directed, remain to be considered; but these great classes of facts afford, as it appears to me, ample and conclusive evidence in favour of the principle of gradual evolution. The strong support derived from the other arguments should, however, always be kept before the mind.

The sole object of this work is to consider, firstly, whether man, like every other species, is descended from some pre-existing form; secondly, the manner of his development; and thirdly, the value of the differences between the so-called races of man. As I shall confine myself to these points, it will not be necessary to describe in detail the differences between the several races—an enormous subject which has been fully discussed in many valuable works. The high antiquity of man has recently been demonstrated by the labours of a host of eminent men, beginning with M. Boucher de Perthes; and this is the indispensable basis for understanding his origin. I shall, therefore, take this conclusion for granted, and may refer my readers to the admirable treatises of Sir Charles Lyell, Sir John Lubbock, and others. Nor shall I have occasion to do more than to allude to the amount of difference between man and the anthropomorphous apes; for Prof. Huxley, in the opinion of most competent judges, has conclusively shewn that in every single visible character man differs less from the higher apes than these do from the lower members of the same order of Primates.

This work contains hardly any original facts in regard to man; but as the conclusions at which I arrived, after drawing up a rough draft, appeared to me interesting, I thought that they might interest others. It has often and confidently been asserted, that man's origin can never be known: but ignorance more frequently begets confidence than does knowledge: it is those who know little, and not those who know much, who so positively assert that this or that problem will never be solved by science. The conclusion that man is the co-descendant with other species of some ancient, lower, and extinct form, is not in any degree new. Lamarck long ago came to this conclusion, which has lately been maintained by several eminent naturalists and philosophers; for instance by Wallace, Huxley, Lyell, Vogt, Lubbock, Büchner, Rolle, &c.,1 and especially by Häckel. This last naturalist, besides his great work, 'Generelle Morphologie' (1866), has recently (1868, with a second edit. in 1870), published his 'Natürliche Schöpfungsgeschichte,' in which he fully discusses the genealogy of man. If this work had appeared before my essay had been written, I should probably never have completed it. Almost all the conclusions at which I have arrived I find confirmed by this naturalist, whose knowledge on many points is much fuller than mine. Wherever I have added any fact or view from Prof. Häckel's writings, I give his authority in the text, other statements I leave as they originally stood in my manuscript, occasionally giving in the foot-notes references to his works, as a confirmation of the more doubtful or interesting points.

During many years it has seemed to me highly probable that sexual selection has played an important part in differentiating the races

of man; but in my 'Origin of Species' (first edition, p. 199) I contented myself by merely alluding to this belief. When I came to apply this view to man, I found it indispensable to treat the whole subject in full detail.2 Consequently the second part of the present work, treating of sexual selection, has extended to an inordinate length, compared with the first part; but this could not be avoided.

I had intended adding to the present volumes an essay on the expression of the various emotions by man and the lower animals. My attention was called to this subject many years ago by Sir Charles Bell's admirable work. This illustrious anatomist maintains that man is endowed with certain muscles solely for the sake of expressing his emotions. As this view is obviously opposed to the belief that man is descended from some other and lower form, it was necessary for me to consider it. I likewise wished to ascertain how far the emotions are expressed in the same manner by the different races of man. But owing to the length of the present work, I have thought it better to reserve my essay, which is partially completed, for separate publication.

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CHAPTER XXI.
GENERAL SUMMARY AND CONCLUSION.

Main conclusion that man is descended from some lower form—Manner of development—Genealogy of man—Intellectual and moral faculties—Sexual selection—Concluding remarks.

A BRIEF summary will here be sufficient to recall to the reader's mind the more salient points in this work. Many of the views which have been advanced are highly speculative, and some no doubt will prove erroneous; but I have in every case given the reasons which have led me to one view rather than to another. It seemed worth while to try how far the principle of evolution would throw light on some of the more complex problems in the natural history of man. False facts are highly injurious to the progress of science, for they often long endure; but false views, if supported by some evidence, do little harm, as every one takes a salutary pleasure in proving their falseness; and when this is done, one path towards error is closed and the road to truth is often at the same time opened.

The main conclusion arrived at in this work, and now held by many naturalists who are well competent to form a sound judgment, is that man is descended from some less highly organised form. The grounds

upon which this conclusion rests will never be shaken, for the close similarity between man and the lower animals in embryonic development, as well as in innumerable points of structure and constitution, both of high and of the most trifling importance,—the rudiments which he retains, and the abnormal reversions to which he is occasionally liable,—are facts which cannot be disputed. They have long been known, but until recently they told us nothing with respect to the origin of man. Now when viewed by the light of our knowledge of the whole organic world, their meaning is unmistakeable. The great principle of evolution stands up clear and firm, when these groups of facts are considered in connection with others, such as the mutual affinities of the members of the same group, their geographical distribution in past and present times, and their geological succession. It is incredible that all these facts should speak falsely. He who is not content to look, like a savage, at the phenomena of nature as disconnected, cannot any longer believe that man is the work of a separate act of creation. He will be forced to admit that the close resemblance of the embryo of man to that, for instance, of a dog—the construction of his skull, limbs, and whole frame, independently of the uses to which the parts may be put, on the same plan with that of other mammals—the occasional reappearance of various structures, for instance of several distinct muscles, which man does not normally possess, but which are common to the Quadrumana—and a crowd of analogous facts—all point in the plainest manner to the conclusion that man is the co-descendant with other mammals of a common progenitor.

We have seen that man incessantly presents individual differences in all parts of his body and in his mental faculties. These differences or variations seem to be induced by the same general causes, and to obey the same laws as with the lower animals. In both cases similar laws of inheritance prevail. Man tends to increase at a greater rate than his means of subsistence; consequently he is occasionally subjected to a severe struggle for existence, and natural selection will have effected whatever lies within its scope. A succession of strongly-marked variations of a similar nature are by no means requisite; slight fluctuating differences in the individual suffice for the work of natural selection. We may feel assured that the inherited effects of the long-continued use or disuse of parts will have done much in the same direction with natural selection. Modifications formerly of importance, though no longer of any special use, will be long inherited. When one part is modified, other parts will change through the principle of correlation, of which we have instances in many curious cases of correlated monstrosities. Something may be attributed to the direct and definite action of the surrounding conditions of life, such as abundant food, heat, or moisture; and lastly, many

characters of slight physiological importance, some indeed of considerable importance, have been gained through sexual selection.

No doubt man, as well as every other animal, presents structures, which as far as we can judge with our little knowledge, are not now of any service to him, nor have been so during any former period of his existence, either in relation to his general conditions of life, or of one sex to the other. Such structures cannot be accounted for by any form of selection, or by the inherited effects of the use and disuse of parts. We know, however, that many strange and strongly-marked peculiarities of structure occasionally appear in our domesticated productions, and if the unknown causes which produce them were to act more uniformly, they would probably become common to all the individuals of the species. We may hope hereafter to understand something about the causes of such occasional modifications, especially through the study of monstrosities: hence the labours of experimentalists, such as those of M. Camille Dareste, are full of promise for the future. In the greater number of cases we can only say that the cause of each slight variation and of each monstrosity lies much more in the nature or constitution of the organism, than in the nature of the surrounding conditions; though new and changed conditions certainly play an important part in exciting organic changes of all kinds.

Through the means just specified, aided perhaps by others as yet undiscovered, man has been raised to his present state. But since he attained to the rank of manhood, he has diverged into distinct races, or as they may be more appropriately called sub-species. Some of these, for instance the Negro and European, are so distinct that, if specimens had been brought to a naturalist without any further information, they would undoubtedly have been considered by him as good and true species. Nevertheless all the races agree in so many unimportant details of structure and in so many mental peculiarities, that these can be accounted for only through inheritance from a common progenitor; and a progenitor thus characterised would probably have deserved to rank as man.

It must not be supposed that the divergence of each race from the other races, and of all the races from a common stock, can be traced back to any one pair of progenitors. On the contrary, at every stage in the process of modification, all the individuals which were in any way best fitted for their conditions of life, though in different degrees, would have survived in greater numbers than the less well fitted. The process would have been like that followed by man, when he does not intentionally select particular individuals, but breeds from all the superior and neglects all the inferior individuals. He thus slowly but surely modifies his stock,

and unconsciously forms a new strain. So with respect to modifications, acquired independently of selection, and due to variations arising from the nature of the organism and the action of the surrounding conditions, or from changed habits of life, no single pair will have been modified in a much greater degree than the other pairs which inhabit the same country, for all will have been continually blended through free intercrossing.

By considering the embryological structure of man,—the homologies which he presents with the lower animals,—the rudiments which he retains,—and the reversions to which he is liable, we can partly recall in imagination the former condition of our early progenitors; and can approximately place them in their proper position in the zoological series. We thus learn that man is descended from a hairy quadruped, furnished with a tail and pointed ears, probably arboreal in its habits, and an inhabitant of the Old World. This creature, if its whole structure had been examined by a naturalist, would have been classed amongst the Quadrumana, as surely as would the common and still more ancient progenitor of the Old and New World monkeys. The Quadrumana and all the higher mammals are probably derived from an ancient marsupial animal, and this through a long line of diversified forms, either from some reptile-like or some amphibian-like creature, and this again from some fish-like animal. In the dim obscurity of the past we can see that the early progenitor of all the Vertebrata must have been an aquatic animal, provided with branchiæ, with the two sexes united in the same individual, and with the most important organs of the body (such as the brain and heart) imperfectly developed. This animal seems to have been more like the larvæ of our existing marine Ascidians than any other known form.

The greatest difficulty which presents itself, when we are driven to the above conclusion on the origin of man, is the high standard of intellectual power and of moral disposition which he has attained. But every one who admits the general principle of evolution, must see that the mental powers of the higher animals, which are the same in kind with those of mankind, though so different in degree, are capable of advancement. Thus the interval between the mental powers of one of the higher apes and of a fish, or between those of an ant and scale-insect, is immense. The development of these powers in animals does not offer any special difficulty; for with our domesticated animals, the mental faculties are certainly variable, and the variations are inherited. No one doubts that these faculties are of the utmost importance to animals in a state of nature. Therefore the conditions are favourable for their development through natural selection. The same conclusion may be extended to man; the intellect must have been all-important to him, even at a very remote period, enabling him to use language, to invent and make weapons, tools,

traps, &c.; by which means, in combination with his social habits, he long ago became the most dominant of all living creatures.

A great stride in the development of the intellect will have followed, as soon as, through a previous considerable advance, the half-art and half-instinct of language came into use; for the continued use of language will have reacted on the brain, and produced an inherited effect; and this again will have reacted on the improvement of language. The large size of the brain in man, in comparison with that of the lower animals, relatively to the size of their bodies, may be attributed in chief part, as Mr. Chauncey Wright has well remarked,1 to the early use of some simple form of language,—that wonderful engine which affixes signs to all sorts of objects and qualities, and excites trains of thought which would never arise from the mere impression of the senses, and if they did arise could not be followed out. The higher intellectual powers of man, such as those of ratiocination, abstraction, self-consciousness, &c., will have followed from the continued improvement of other mental faculties; but without considerable culture of the mind, both in the race and in the individual, it is doubtful whether these high powers would be exercised, and thus fully attained.

The development of the moral qualities is a more interesting and difficult problem. Their foundation lies in the social instincts, including in this term the family ties. These instincts are of a highly complex nature, and in the case of the lower animals give special tendencies towards certain definite actions; but the more important elements for us are love, and the distinct emotion of sympathy. Animals endowed with the social instincts take pleasure in each other's company, warn each other of danger, defend and aid each other in many ways. These instincts are not extended to all the individuals of the species, but only to those of the same community. As they are highly beneficial to the species, they have in all probability been acquired through natural selection.

A moral being is one who is capable of comparing his past and future actions and motives,—of approving of some and disapproving of others; and the fact that man is the one being who with certainty can be thus designated makes the greatest of all distinctions between him and the lower animals. But in our third chapter I have endeavoured to shew that the moral sense follows, firstly, from the enduring and always present nature of the social instincts, in which respect man agrees with the lower animals; and secondly, from his mental faculties being highly active and his impressions of past events extremely vivid, in which respects he differs from the lower animals. Owing to this condition of mind, man cannot avoid looking backwards and comparing the impressions of past events and actions. He also continually looks forward.

Hence after some temporary desire or passion has mastered his social instincts, he will reflect and compare the now weakened impression of such past impulses, with the ever present social instinct; and he will then feel that sense of dissatisfaction which all unsatisfied instincts leave behind them. Consequently he resolves to act differently for the future—and this is conscience. Any instinct which is permanently stronger or more enduring than another, gives rise to a feeling which we express by saying that it ought to be obeyed. A pointer dog, if able to reflect on his past conduct, would say to himself, I ought (as indeed we say of him) to have pointed at that hare and not have yielded to the passing temptation of hunting it.

Social animals are partly impelled by a wish to aid the members of the same community in a general manner, but more commonly to perform certain definite actions. Man is impelled by the same general wish to aid his fellows, but has few or no special instincts. He differs also from the lower animals in being able to express his desires by words, which thus become the guide to the aid required and bestowed. The motive to give aid is likewise somewhat modified in man: it no longer consists solely of a blind instinctive impulse, but is largely influenced by the praise or blame of his fellow men. Both the appreciation and the bestowal of praise and blame rest on sympathy; and this emotion, as we have seen, is one of the most important elements of the social instincts. Sympathy, though gained as an instinct, is also much strengthened by exercise or habit. As all men desire their own happiness, praise or blame is bestowed on actions and motives, according as they lead to this end; and as happiness is an essential part of the general good, the greatest-happiness principle indirectly serves as a nearly safe standard of right and wrong. As the reasoning powers advance and experience is gained, the more remote effects of certain lines of conduct on the character of the individual, and on the general good, are perceived; and then the self-regarding virtues, from coming within the scope of public opinion, receive praise, and their opposites receive blame. But with the less civilised nations reason often errs, and many bad customs and base superstitions come within the same scope, and consequently are esteemed as high virtues, and their breach as heavy crimes.

The moral faculties are generally esteemed, and with justice, as of higher value than the intellectual powers. But we should always bear in mind that the activity of the mind in vividly recalling past impressions is one of the fundamental though secondary bases of conscience. This fact affords the strongest argument for educating and stimulating in all possible ways the intellectual faculties of every human being. No doubt a man with a torpid mind, if his social affections and sympathies are well

developed, will be led to good actions, and may have a fairly sensitive conscience. But whatever renders the imagination of men more vivid and strengthens the habit of recalling and comparing past impressions, will make the conscience more sensitive, and may even compensate to a certain extent for weak social affections and sympathies.

The moral nature of man has reached the highest standard as yet attained, partly through the advancement of the reasoning powers and consequently of a just public opinion, but especially through the sympathies being rendered more tender and widely diffused through the effects of habit, example, instruction, and reflection. It is not improbable that virtuous tendencies may through long practice be inherited. With the more civilised races, the conviction of the existence of an all-seeing Deity has had a potent influence on the advancement of morality. Ultimately man no longer accepts the praise or blame of his fellows as his chief guide, though few escape this influence, but his habitual convictions controlled by reason afford him the safest rule. His conscience then becomes his supreme judge and monitor. Nevertheless the first foundation or origin of the moral sense lies in the social instincts, including sympathy; and these instincts no doubt were primarily gained, as in the case of the lower animals, through natural selection.

The belief in God has often been advanced as not only the greatest, but the most complete of all the distinctions between man and the lower animals. It is however impossible, as we have seen, to maintain that this belief is innate or instinctive in man. On the other hand a belief in all-pervading spiritual agencies seems to be universal; and apparently follows from a considerable advance in the reasoning powers of man, and from a still greater advance in his faculties of imagination, curiosity and wonder. I am aware that the assumed instinctive belief in God has been used by many persons as an argument for His existence. But this is a rash argument, as we should thus be compelled to believe in the existence of many cruel and malignant spirits, possessing only a little more power than man; for the belief in them is far more general than of a beneficent Deity. The idea of a universal and beneficent Creator of the universe does not seem to arise in the mind of man, until he has been elevated by long-continued culture.

He who believes in the advancement of man from some lowly-organised form, will naturally ask how does this bear on the belief in the immortality of the soul. The barbarous races of man, as Sir J. Lubbock has shewn, possess no clear belief of this kind; but arguments derived from the primeval beliefs of savages are, as we have just seen, of little or no avail. Few persons feel any anxiety from the impossibility of determining at what precise period in the development of the individual, from the first

trace of the minute germinal vesicle to the child either before or after birth, man becomes an immortal being; and there is no greater cause for anxiety because the period in the gradually ascending organic scale cannot possibly be determined.

I am aware that the conclusions arrived at in this work will be denounced by some as highly irreligious; but he who thus denounces them is bound to shew why it is more irreligious to explain the origin of man as a distinct species by descent from some lower form, through the laws of variation and natural selection, than to explain the birth of the individual through the laws of ordinary reproduction. The birth both of the species and of the individual are equally parts of that grand sequence of events, which our minds refuse to accept as the result of blind chance. The understanding revolts at such a conclusion, whether or not we are able to believe that every slight variation of structure,—the union of each pair in marriage,—the dissemination of each seed,—and other such events, have all been ordained for some special purpose.

Sexual selection has been treated at great length in these volumes; for, as I have attempted to shew, it has played an important part in the history of the organic world. As summaries have been given to each chapter, it would be superfluous here to add a detailed summary. I am aware that much remains doubtful, but I have endeavoured to give a fair view of the whole case. In the lower divisions of the animal kingdom, sexual selection seems to have done nothing: such animals are often affixed for life to the same spot, or have the two sexes combined in the same individual, or what is still more important, their perceptive and intellectual faculties are not sufficiently advanced to allow of the feelings of love and jealousy, or of the exertion of choice. When, however, we come to the Arthropoda and Vertebrata, even to the lowest classes in these two great Sub-Kingdoms, sexual selection has effected much; and it deserves notice that we here find the intellectual faculties developed, but in two very distinct lines, to the highest standard, namely in the Hymenoptera (ants, bees, &c.) amongst the Arthropoda, and in the Mammalia, including man, amongst the Vertebrata.

In the most distinct classes of the animal kingdom, with mammals, birds, reptiles, fishes, insects, and even crustaceans, the differences between the sexes follow almost exactly the same rules. The males are almost always the wooers; and they alone are armed with special weapons for fighting with their rivals. They are generally stronger and larger than the females, and are endowed with the requisite qualities of courage and pugnacity. They are provided, either exclusively or in a much higher degree than the females, with organs for producing vocal or instrumental music, and with odoriferous glands. They are ornamented

with infinitely diversified appendages, and with the most brilliant or conspicuous colours, often arranged in elegant patterns, whilst the females are left unadorned. When the sexes differ in more important structures, it is the male which is provided with special sense-organs for discovering the female, with locomotive organs for reaching her, and often with prehensile organs for holding her. These various structures for securing or charming the female are often developed in the male during only part of the year, namely the breeding season. They have in many cases been transferred in a greater or less degree to the females; and in the latter case they appear in her as mere rudiments. They are lost by the males after emasculation. Generally they are not developed in the male during early youth, but appear a short time before the age for reproduction. Hence in most cases the young of both sexes resemble each other; and the female resembles her young offspring throughout life. In almost every great class a few anomalous cases occur in which there has been an almost complete transposition of the characters proper to the two sexes; the females assuming characters which properly belong to the males. This surprising uniformity in the laws regulating the differences between the sexes in so many and such widely separated classes, is intelligible if we admit the action throughout all the higher divisions of the animal kingdom of one common cause, namely sexual selection.

Sexual selection depends on the success of certain individuals over others of the same sex in relation to the propagation of the species; whilst natural selection depends on the success of both sexes, at all ages, in relation to the general conditions of life. The sexual struggle is of two kinds; in the one it is between the individuals of the same sex, generally the male sex, in order to drive away or kill their rivals, the females remaining passive; whilst in the other, the struggle is likewise between the individuals of the same sex, in order to excite or charm those of the opposite sex, generally the females, which no longer remain passive, but select the more agreeable partners. This latter kind of selection is closely analogous to that which man unintentionally, yet effectually, brings to bear on his domesticated productions, when he continues for a long time choosing the most pleasing or useful individuals, without any wish to modify the breed.

The laws of inheritance determine whether characters gained through sexual selection by either sex shall be transmitted to the same sex, or to both sexes; as well as the age at which they shall be developed. It appears that variations which arise late in life are commonly transmitted to one and the same sex. Variability is the necessary basis for the action of selection, and is wholly independent of it. It follows from this, that variations of the same general nature have often been taken

advantage of and accumulated through sexual selection in relation to the propagation of the species, and through natural selection in relation to the general purposes of life. Hence secondary sexual characters, when equally transmitted to both sexes can be distinguished from ordinary specific characters only by the light of analogy. The modifications acquired through sexual selection are often so strongly pronounced that the two sexes have frequently been ranked as distinct species, or even as distinct genera. Such strongly-marked differences must be in some manner highly important; and we know that they have been acquired in some instances at the cost not only of inconvenience, but of exposure to actual danger.

The belief in the power of sexual selection rests chiefly on the following considerations. The characters which we have the best reason for supposing to have been thus acquired are confined to one sex; and this alone renders it probable that they are in some way connected with the act of reproduction. These characters in innumerable instances are fully developed only at maturity; and often during only a part of the year, which is always the breeding-season. The males (passing over a few exceptional cases) are the most active in courtship; they are the best armed, and are rendered the most attractive in various ways. It is to be especially observed that the males display their attractions with elaborate care in the presence of the females; and that they rarely or never display them excepting during the season of love. It is incredible that all this display should be purposeless. Lastly we have distinct evidence with some quadrupeds and birds that the individuals of the one sex are capable of feeling a strong antipathy or preference for certain individuals of the opposite sex.

Bearing these facts in mind, and not forgetting the marked results of man's unconscious selection, it seems to me almost certain that if the individuals of one sex were during a long series of generations to prefer pairing with certain individuals of the other sex, characterised in some peculiar manner, the offspring would slowly but surely become modified in this same manner. I have not attempted to conceal that, excepting when the males are more numerous than the females, or when polygamy prevails, it is doubtful how the more attractive males succeed in leaving a larger number of off-spring to inherit their superiority in ornaments or other charms than the less attractive males; but I have shewn that this would probably follow from the females,—especially the more vigorous females which would be the first to breed, preferring not only the more attractive but at the same time the more vigorous and victorious males.

Although we have some positive evidence that birds appreciate bright and beautiful objects, as with the Bower-birds of Australia, and

although they certainly appreciate the power of song, yet I fully admit that it is an astonishing fact that the females of many birds and some mammals should be endowed with sufficient taste for what has apparently been effected through sexual selection; and this is even more astonishing in the case of reptiles, fish, and insects. But we really know very little about the minds of the lower animals. It cannot be supposed that male Birds of Paradise or Peacocks, for instance, should take so much pains in erecting, spreading, and vibrating their beautiful plumes before the females for no purpose. We should remember the fact given on excellent authority in a former chapter, namely that several peahens, when debarred from an admired male, remained widows during a whole season rather than pair with another bird.

Nevertheless I know of no fact in natural history more wonderful than that the female Argus pheasant should be able to appreciate the exquisite shading of the ball-and-socket ornaments and the elegant patterns on the wing-feathers of the male. He who thinks that the male was created as he now exists must admit that the great plumes, which prevent the wings from being used for flight, and which, as well as the primary feathers, are displayed in a manner quite peculiar to this one species during the act of courtship, and at no other time, were given to him as an ornament. If so, he must likewise admit that the female was created and endowed with the capacity of appreciating such ornaments. I differ only in the conviction that the male Argus pheasant acquired his beauty gradually, through the females having preferred during many generations the more highly ornamented males; the æsthetic capacity of the females having been advanced through exercise or habit in the same manner as our own taste is gradually improved. In the male, through the fortunate chance of a few feathers not having been modified, we can distinctly see how simple spots with a little fulvous shading on one side might have been developed by small and graduated steps into the wonderful ball-and-socket ornaments; and it is probable that they were actually thus developed.

Everyone who admits the principle of evolution, and yet feels great difficulty in admitting that female mammals, birds, reptiles, and fish, could have acquired the high standard of taste which is implied by the beauty of the males, and which generally coincides with our own standard, should reflect that in each member of the vertebrate series the nerve-cells of the brain are the direct offshoots of those possessed by the common progenitor of the whole group. It thus becomes intelligible that the brain and mental faculties should be capable under similar conditions of nearly the same course of development, and consequently of performing nearly the same functions.

The reader who has taken the trouble to go through the several chapters devoted to sexual selection, will be able to judge how far the conclusions at which I have arrived are supported by sufficient evidence. If he accepts these conclusions, he may, I think, safely extend them to mankind; but it would be superfluous here to repeat what I have so lately said on the

manner in which sexual selection has apparently acted on both the male and female side, causing the two sexes of man to differ in body and mind, and the several races to differ from each other in various characters, as well as from their ancient and lowly-organised progenitors.

He who admits the principle of sexual selection will be led to the remarkable conclusion that the cerebral system not only regulates most of the existing functions of the body, but has indirectly influenced the progressive development of various bodily structures and of certain mental qualities. Courage, pugnacity, perseverance, strength and size of body, weapons of all kinds, musical organs, both vocal and instrumental, bright colours, stripes and marks, and ornamental appendages, have all been indirectly gained by the one sex or the other, through the influence of love and jealousy, through the appreciation of the beautiful in sound, colour or form, and through the exertion of a choice; and these powers of the mind manifestly depend on the development of the cerebral system.

Man scans with scrupulous care the character and pedigree of his horses, cattle, and dogs before he matches them; but when he comes to his own marriage he rarely, or never, takes any such care. He is impelled by nearly the same motives as are the lower animals when left to their own free choice, though he is in so far superior to them that he highly values mental charms and virtues. On the other hand he is strongly attracted by mere wealth or rank. Yet he might by selection do something not only for the bodily constitution and frame of his offspring, but for their intellectual and moral qualities. Both sexes ought to refrain from marriage if in any marked degree inferior in body or mind; but such hopes are Utopian and will never be even partially realised until the laws of inheritance are thoroughly known. All do good service who aid towards this end. When the principles of breeding and of inheritance are better understood, we shall not hear ignorant members of our legislature rejecting with scorn a plan for ascertaining by an easy method whether or not consanguineous marriages are injurious to man.

The advancement of the welfare of mankind is a most intricate problem: all ought to refrain from marriage who cannot avoid abject poverty for their children; for poverty is not only a great evil, but tends to its own increase by leading to recklessness in marriage. On the other hand, as Mr. Galton has remarked, if the prudent avoid marriage, whilst the reckless marry, the inferior members will tend to supplant the better members of society. Man, like every other animal, has no doubt advanced to his present high condition through a struggle for existence consequent on his rapid multiplication; and if he is to advance still higher he must remain subject to a severe struggle. Otherwise he would soon sink into indolence, and the more highly-gifted men would not be more successful in the battle of life than the less gifted. Hence our natural rate of increase, though leading to many and obvious evils, must not be greatly diminished by any means. There should be open competition for all men; and the most able should not be prevented by

laws or customs from succeeding best and rearing the largest number of offspring. Important as the struggle for existence has been and even still is, yet as far as the highest part of man's nature is concerned there are other agencies more important. For the moral qualities are advanced, either directly or indirectly, much more through the effects of habit, the reasoning powers, instruction, religion, &c., than through natural selection; though to this latter agency the social instincts, which afforded the basis for the development of the moral sense, may be safely attributed.

The main conclusion arrived at in this work, namely that man is descended from some lowly-organised form, will, I regret to think, be highly distasteful to many persons. But there can hardly be a doubt that we are descended from barbarians. The astonishment which I felt on first seeing a party of Fuegians on a wild and broken shore will never be forgotten by me, for the reflection at once rushed into my mind—such were our ancestors. These men were absolutely naked and bedaubed with paint, their long hair was tangled, their mouths frothed with excitement, and their expression was wild, startled, and distrustful. They possessed hardly any arts, and like wild animals lived on what they could catch; they had no government, and were merciless to every one not of their own small tribe. He who has seen a savage in his native land will not feel much shame, if forced to acknowledge that the blood of some more humble creature flows in his veins. For my own part I would as soon be descended from that heroic little monkey, who braved his dreaded enemy in order to save the life of his keeper; or from that old baboon, who, descending from the mountains, carried away in triumph his young comrade from a crowd of astonished dogs—as from a savage who delights to torture his enemies, offers up bloody sacrifices, practises infanticide without remorse, treats his wives like slaves, knows no decency, and is haunted by the grossest superstitions.

Man may be excused for feeling some pride at having risen, though not through his own exertions, to the very summit of the organic scale; and the fact of his having thus risen, instead of having been aboriginally placed there, may give him hopes for a still higher destiny in the distant future. But we are not here concerned with hopes or fears, only with the truth as far as our reason allows us to discover it. I have given the evidence to the best of my ability; and we must acknowledge, as it seems to me, that man with all his noble qualities, with sympathy which feels for the most debased, with benevolence which extends not only to other men but to the humblest living creature, with his god-like intellect which has penetrated into the movements and constitution of the solar system—with all these exalted powers—Man still bears in his bodily frame the indelible stamp of his lowly origin.

Summa Theologica I.118
St. Thomas Aquinas

Article 1. Whether the sensitive soul is transmitted with the semen?

Objection 1. It would seem that the sensitive soul is not transmitted with the semen, but created by God. For every perfect substance, not composed of matter and form, that begins to exist, acquires existence not by generation, but by creation: for nothing is generated save from matter. But the sensitive soul is a perfect substance, otherwise it could not move the body; and since it is the form of a body, it is not composed of matter and form. Therefore it begins to exist not by generation but by creation.

Objection 2. Further, in living things the principle of generation is the generating power; which, since it is one of the powers of the vegetative soul, is of a lower order than the sensitive soul. Now nothing acts beyond its species. Therefore the sensitive soul cannot be caused by the animal's generating power.

Objection 3. Further, the generator begets its like: so that the form of the generator must be actually in the cause of generation. But neither the sensitive soul itself nor any part thereof is actually in the semen, for no part of the sensitive soul is elsewhere than in some part of the body; while in the semen there is not even a particle of the body, because there is not a particle of the body which is not made from the semen and by the power thereof. Therefore the sensitive soul is not produced through the semen.

Objection 4. Further, if there be in the semen any principle productive of the sensitive soul, this principle either remains after the animal is begotten, or it does not remain. Now it cannot remain. For either it would be identified with the sensitive soul of the begotten animal; which is impossible, for thus there would be identity between begetter and begotten, maker and made: or it would be distinct therefrom; and again this is impossible, for it has been proved above (Question 76, Article 4) that in one animal there is but one formal principle, which is the soul. If on the other hand the aforesaid principle does not remain, this again seems to be impossible: for thus an agent would act to its own destruction, which cannot be. Therefore the sensitive soul cannot be generated from the semen.

On the contrary, The power in the semen is to the animal seminally generated, as the power in the elements of the world is to animals produced from these elements--for instance by putrefaction. But in the latter animals the soul is produced by the elemental power, according to Genesis 1:20: "Let the waters bring forth the creeping creatures having

life." Therefore also the souls of animals seminally generated are produced by the seminal power.

I answer that, Some have held that the sensitive souls of animals are created by God (65, 4). This opinion would hold if the sensitive soul were subsistent, having being and operation of itself. For thus, as having being and operation of itself, to be made would needs be proper to it. And since a simple and subsistent thing cannot be made except by creation, it would follow that the sensitive soul would arrive at existence by creation.

But this principle is false--namely, that being and operation are proper to the sensitive soul, as has been made clear above (Question 75, Article 3): for it would not cease to exist when the body perishes. Since, therefore, it is not a subsistent form, its relation to existence is that of the corporeal forms, to which existence does not belong as proper to them, but which are said to exist forasmuch as the subsistent composites exist through them.

Wherefore to be made is proper to composites. And since the generator is like the generated, it follows of necessity that both the sensitive soul, and all other like forms are naturally brought into existence by certain corporeal agents that reduce the matter from potentiality to act, through some corporeal power of which they are possessed.

Now the more powerful an agent, the greater scope its action has: for instance, the hotter a body, the greater the distance to which its heat carries. Therefore bodies not endowed with life, which are the lowest in the order of nature, generate their like, not through some medium, but by themselves; thus fire by itself generates fire. But living bodies, as being more powerful, act so as to generate their like, both without and with a medium. Without a medium--in the work of nutrition, in which flesh generates flesh: with a medium--in the act of generation, because the semen of the animal or plant derives a certain active force from the soul of the generator, just as the instrument derives a certain motive power from the principal agent. And as it matters not whether we say that something is moved by the instrument or by the principal agent, so neither does it matter whether we say that the soul of the generated is caused by the soul of the generator, or by some seminal power derived therefrom.

Reply to Objection 1. The sensitive soul is not a perfect self-subsistent substance. We have said enough (25, 3) on this point, nor need we repeat it here.

Reply to Objection 2. The generating power begets not only by its own virtue but by that of the whole soul, of which it is a power. Therefore the generating power of a plant generates a plant, and that of an animal

begets an animal. For the more perfect the soul is, to so much a more perfect effect is its generating power ordained.

Reply to Objection 3. This active force which is in the semen, and which is derived from the soul of the generator, is, as it were, a certain movement of this soul itself: nor is it the soul or a part of the soul, save virtually; thus the form of a bed is not in the saw or the axe, but a certain movement towards that form. Consequently there is no need for this active force to have an actual organ; but it is based on the (vital) spirit in the semen which is frothy, as is attested by its whiteness. In which spirit, moreover, there is a certain heat derived from the power of the heavenly bodies, by virtue of which the inferior bodies also act towards the production of the species as stated above (115, 3, ad 2). And since in this (vital) spirit the power of the soul is concurrent with the power of a heavenly body, it has been said that "man and the sun generate man." Moreover, elemental heat is employed instrumentally by the soul's power, as also by the nutritive power, as stated (De Anima ii, 4).

Reply to Objection 4. In perfect animals, generated by coition, the active force is in the semen of the male, as the Philosopher says (De Gener. Animal. ii, 3); but the foetal matter is provided by the female. In this matter, the vegetative soul exists from the very beginning, not as to the second act, but as to the first act, as the sensitive soul is in one who sleeps. But as soon as it begins to attract nourishment, then it already operates in act. This matter therefore is transmuted by the power which is in the semen of the male, until it is actually informed by the sensitive soul; not as though the force itself which was in the semen becomes the sensitive soul; for thus, indeed, the generator and generated would be identical; moreover, this would be more like nourishment and growth than generation, as the Philosopher says. And after the sensitive soul, by the power of the active principle in the semen, has been produced in one of the principal parts of the thing generated, then it is that the sensitive soul of the offspring begins to work towards the perfection of its own body, by nourishment and growth. As to the active power which was in the semen, it ceases to exist, when the semen is dissolved and the (vital) spirit thereof vanishes. Nor is there anything unreasonable in this, because this force is not the principal but the instrumental agent; and the movement of an instrument ceases when once the effect has been produced.

Article 2. Whether the intellectual soul is produced from the semen?

Objection 1. It would seem that the intellectual soul is produced from the semen. For it is written (Genesis 46:26): "All the souls that came out of [Jacob's] thigh, sixty-six." But nothing is produced from the thigh of a

man, except from the semen. Therefore the intellectual soul is produced from the semen.

Objection 2. Further, as shown above (Question 76, Article 3), the intellectual, sensitive, and nutritive souls are, in substance, one soul in man. But the sensitive soul in man is generated from the semen, as in other animals; wherefore the Philosopher says (De Gener. Animal. ii, 3) that the animal and the man are not made at the same time, but first of all the animal is made having a sensitive soul. Therefore also the intellectual soul is produced from the semen.

Objection 3. Further, it is one and the same agent whose action is directed to the matter and to the form: else from the matter and the form there would not result something simply one. But the intellectual soul is the form of the human body, which is produced by the power of the semen. Therefore the intellectual soul also is produced by the power of the semen.

Objection 4. Further, man begets his like in species. But the human species is constituted by the rational soul. Therefore the rational soul is from the begetter.

Objection 5. Further, it cannot be said that God concurs in sin. But if the rational soul be created by God, sometimes God concurs in the sin of adultery, since sometimes offspring is begotten of illicit intercourse. Therefore the rational soul is not created by God.

On the contrary, It is written in De Eccl. Dogmat. xiv that "the rational soul is not engendered by coition."

I answer that, It is impossible for an active power existing in matter to extend its action to the production of an immaterial effect. Now it is manifest that the intellectual principle in man transcends matter; for it has an operation in which the body takes no part whatever. It is therefore impossible for the seminal power to produce the intellectual principle.

Again, the seminal power acts by virtue of the soul of the begetter according as the soul of the begetter is the act of the body, making use of the body in its operation. Now the body has nothing whatever to do in the operation of the intellect. Therefore the power of the intellectual principle, as intellectual, cannot reach the semen. Hence the Philosopher says (De Gener. Animal. ii, 3): "It follows that the intellect alone comes from without."

Again, since the intellectual soul has an operation independent of the body, it is subsistent, as proved above (Question 75, Article 2): therefore to be and to be made are proper to it. Moreover, since it is an immaterial substance it cannot be caused through generation, but only through creation by God. Therefore to hold that the intellectual soul is caused by the begetter, is nothing else than to hold the soul to be non-

subsistent and consequently to perish with the body. It is therefore heretical to say that the intellectual soul is transmitted with the semen.

Reply to Objection 1. In the passage quoted, the part is put instead of the whole, the soul for the whole man, by the figure of synecdoche.

Reply to Objection 2. Some say that the vital functions observed in the embryo are not from its soul, but from the soul of the mother; or from the formative power of the semen. Both of these explanations are false; for vital functions such as feeling, nourishment, and growth cannot be from an extrinsic principle. Consequently it must be said that the soul is in the embryo; the nutritive soul from the beginning, then the sensitive, lastly the intellectual soul.

Therefore some say that in addition to the vegetative soul which existed first, another, namely the sensitive, soul supervenes; and in addition to this, again another, namely the intellectual soul. Thus there would be in man three souls of which one would be in potentiality to another. This has been disproved above (Question 76, Article 3).

Therefore others say that the same soul which was at first merely vegetative, afterwards through the action of the seminal power, becomes a sensitive soul; and finally this same soul becomes intellectual, not indeed through the active seminal power, but by the power of a higher agent, namely God enlightening (the soul) from without. For this reason the Philosopher says that the intellect comes from without. But this will not hold.

First, because no substantial form is susceptible of more or less; but addition of greater perfection constitutes another species, just as the addition of unity constitutes another species of number. Now it is not possible for the same identical form to belong to different species.

Secondly, because it would follow that the generation of an animal would be a continuous movement, proceeding gradually from the imperfect to the perfect, as happens in alteration.

Thirdly, because it would follow that the generation of a man or an animal is not generation simply, because the subject thereof would be a being in act. For if the vegetative soul is from the beginning in the matter of offspring, and is subsequently gradually brought to perfection; this will imply addition of further perfection without corruption of the preceding perfection. And this is contrary to the nature of generation properly so called.

Fourthly, because either that which is caused by the action of God is something subsistent: and thus it must needs be essentially distinct from the pre-existing form, which was non-subsistent; and we shall then come back to the opinion of those who held the existence of several souls in the body--or else it is not subsistent, but a perfection of the pre-existing soul:

and from this it follows of necessity that the intellectual soul perishes with the body, which cannot be admitted.

There is again another explanation, according to those who held that all men have but one intellect in common: but this has been disproved above (Question 76, Article 2).

We must therefore say that since the generation of one thing is the corruption of another, it follows of necessity that both in men and in other animals, when a more perfect form supervenes the previous form is corrupted: yet so that the supervening form contains the perfection of the previous form, and something in addition. It is in this way that through many generations and corruptions we arrive at the ultimate substantial form, both in man and other animals. This indeed is apparent to the senses in animals generated from putrefaction. We conclude therefore that the intellectual soul is created by God at the end of human generation, and this soul is at the same time sensitive and nutritive, the pre-existing forms being corrupted.

Reply to Objection 3. This argument holds in the case of diverse agents not ordered to one another. But where there are many agents ordered to one another, nothing hinders the power of the higher agent from reaching to the ultimate form; while the powers of the inferior agents extend only to some disposition of matter: thus in the generation of an animal, the seminal power disposes the matter, but the power of the soul gives the form. Now it is manifest from what has been said above (105, 5; 110, 1) that the whole of corporeal nature acts as the instrument of a spiritual power, especially of God. Therefore nothing hinders the formation of the body from being due to a corporeal power, while the intellectual soul is from God alone.

Reply to Objection 4. Man begets his like, forasmuch as by his seminal power the matter is disposed for the reception of a certain species of form.

Reply to Objection 5. In the action of the adulterer, what is of nature is good; in this God concurs. But what there is of inordinate lust is evil; in this God does not concur.

Article 3. Whether human souls were created together at the beginning of the world?

Objection 1. It would seem that human souls were created together at the beginning of the world. For it is written (Genesis 2:2): "God rested He from all His work which He had done." This would not be true if He created new souls every day. Therefore all souls were created at the same time.

Objection 2. Further, spiritual substances before all others belong to the perfection of the universe. If therefore souls were created with the bodies, every day innumerable spiritual substances would be added to the perfection of the universe: consequently at the beginning the universe would have been imperfect. This is contrary to Genesis 2:2, where it is said that "God ended" all "His work."

Objection 3. Further, the end of a thing corresponds to its beginning. But the intellectual soul remains, when the body perishes. Therefore it began to exist before the body.

On the contrary, It is said (De Eccl. Dogmat. xiv, xviii) that "the soul is created together with the body."

I answer that, Some have maintained that it is accidental to the intellectual soul to be united to the body, asserting that the soul is of the same nature as those spiritual substances which are not united to a body. These, therefore, stated that the souls of men were created together with the angels at the beginning. But this statement is false.

Firstly, in the very principle on which it is based. For if it were accidental to the soul to be united to the body, it would follow that man who results from this union is a being by accident; or that the soul is a man, which is false, as proved above (Question 75, Article 4). Moreover, that the human soul is not of the same nature as the angels, is proved from the different mode of understanding, as shown above (55, 2; 85, 1): for man understands through receiving from the senses, and turning to phantasms, as stated above (84, 6,7; 85, 1). For this reason the soul needs to be united to the body, which is necessary to it for the operation of the sensitive part: whereas this cannot be said of an angel.

Secondly, this statement can be proved to be false in itself. For if it is natural to the soul to be united to the body, it is unnatural to it to be without a body, and as long as it is without a body it is deprived of its natural perfection. Now it was not fitting that God should begin His work with things imperfect and unnatural, for He did not make man without a hand or a foot, which are natural parts of a man. Much less, therefore, did He make the soul without a body.

But if someone say that it is not natural to the soul to be united to the body, he must give the reason why it is united to a body. And the reason must be either because the soul so willed, or for some other reason. If because the soul willed it--this seems incongruous.

First, because it would be unreasonable of the soul to wish to be united to the body, if it did not need the body: for if it did need it, it would be natural for it to be united to it, since "nature does not fail in what is necessary."

Secondly, because there would be no reason why, having been created from the beginning of the world, the soul should, after such a long time, come to wish to be united to the body. For a spiritual substance is above time, and superior to the heavenly revolutions.

Thirdly, because it would seem that this body was united to this soul by chance: since for this union to take place two wills would have to concur--to wit, that of the incoming soul, and that of the begetter. If, however, this union be neither voluntary nor natural on the part of the soul, then it must be the result of some violent cause, and to the soul would have something of a penal and afflicting nature. This is in keeping with the opinion of Origen, who held that souls were embodies in punishment of sin. Since, therefore, all these opinions are unreasonable, we must simply confess that souls were not created before bodies, but are created at the same time as they are infused into them.

Reply to Objection 1. God is said to have rested on the seventh day, not from all work, since we read (John 5:17): "My Father worketh until now"; but from the creation of any new genera and species, which may not have already existed in the first works. For in this sense, the souls which are created now, existed already, as to the likeness of the species, in the first works, which included the creation of Adam's soul.

Reply to Objection 2. Something can be added every day to the perfection of the universe, as to the number of individuals, but not as to the number of species.

Reply to Objection 3. That the soul remains without the body is due to the corruption of the body, which was a result of sin. Consequently it was not fitting that God should make the soul without the body from the beginning: for as it is written (Wisdom 1:13-16): "God made not death . . . but the wicked with works and words have called it to them."

The Copenhagen Interpretation of Quantum Theory

Werner Heisenberg

Source: Physics and Philosophy, 1958; Chapters 2 (History), 3 (Copenhagen interpretation) and 5 (HPS), reproduced here; Published: by George Allen and Unwin Edition, 1959.

THE Copenhagen interpretation of quantum theory starts from a paradox. Any experiment in physics, whether it refers to the phenomena of daily life or to atomic events, is to be described in the terms of classical physics. The concepts of classical physics form the language by which we describe the arrangements of our experiments and state the results. We cannot and should not replace these concepts by any others. Still the application of these concepts is limited by the relations of uncertainty. We must keep in mind this limited range of applicability of the classical concepts while using them, but we cannot and should not try to improve them.

For a better understanding of this paradox it is useful to compare the procedure for the theoretical interpretation of an experiment in classical physics and in quantum theory. In Newton's mechanics, for instance, we may start by measuring the position and the velocity of the planet whose motion we are going to study. The result of the observation is translated into mathematics by deriving numbers for the co-ordinates and the momenta of the planet from the observation. Then the equations of motion are used to derive from these values of the co-ordinates and momenta at a given time the values of these co-ordinates or any other properties of the system at a later time, and in this way the astronomer can predict the properties of the system at a later time. He can, for instance, predict the exact time for an eclipse of the moon.

In quantum theory the procedure is slightly different. We could for instance be interested in the motion of an electron through a cloud chamber and could determine by some kind of observation the initial position and velocity of the electron. But this determination will not be accurate- it will at least contain the inaccuracies following from the uncertainty relations and will probably contain still larger errors due to the difficulty of the experiment. It is the first of these inaccuracies which allows us to translate the result of the observation into the mathematical scheme of quantum theory. A probability function is written down which represents the experimental situation at the time of the measurement, including even the possible errors of the measurement.

This probability function represents a mixture of two things, partly a fast and partly our knowledge of a fact. It represents a fact in so far as it assigns at the initial time the probability unity (i.e., complete

certainty) to the initial situation: the electron moving with the observed velocity at the observed position; 'observed' means observed within the accuracy of the experiment. It represents our knowledge in so far as another observer could perhaps know the position of the electron more accurately. The error in the experiment does - at least to some extent - not represent a property of the electron but a deficiency in our knowledge of the electron. Also this deficiency of knowledge is expressed in the probability function.

In classical physics one should in a careful investigation also consider the error of the observation. As a result one would get a probability distribution for the initial values of the co-ordinates and velocities and therefore something very similar to the probability function in quantum mechanics. Only the necessary uncertainty due to the uncertainty relations is lacking in classical physics.

When the probability function in quantum theory has been determined at the initial time from the observation, one can from the laws of quantum theory calculate the probability function at any later time and can thereby determine the probability for a measurement giving a specified value of the measured quantity. We can, for instance, predict the probability for finding the electron at a later time at a given point in the cloud chamber. It should be emphasised, however, that the probability function does not in itself represent a course of events in the course of time. It represents a tendency for events and our knowledge of events. l he probability function can be connected with reality only if one essential condition is fulfilled: if a new measurement is made to determine a certain property of the system. Only then does the probability function allow us to calculate the probable result of the new measurement. The result of the measurement again will be stated in terms of classical physics.

Therefore, the theoretical-interpretation of an experiment requires three distinct steps: (I) the translation of the initial experimental situation into a probability function; (2) the following up of this function in the course of time; (3) the statement of a new measurement to be made of the system, the result of which can then be calculated from the probability function. For the first step the fulfilment of the uncertainty relations is a necessary condition. The second step cannot be described in terms of the classical concepts; there is no description of what happens to the system between the initial observation and the next measurement. It is only in the third step that we change over again from the 'possible' to the 'actual'.

Let us illustrate these three steps in a simple ideal experiment. It has been said that the atom consists of a nucleus and electrons moving

around the nucleus; it has also been stated that the concept of an electronic orbit is doubtful. One could argue that it should at least in principle be possible to observe the electron in its orbit. One should simply look at the atom through a microscope of a very high revolving power, then one would see the electron moving in its orbit. Such a high revolving power could to be sure not be obtained by a microscope using ordinary light, since the inaccuracy of the measurement of the position can never be smaller than the wave length of the light. But a microscope using ~~-rays with a wave length smaller than the size of the atom would do. Such a microscope has not yet been constructed but that should not prevent us from discussing the ideal experiment.

Is the first step, the translation of the result of the observation into a probability function, possible? It is possible only if the uncertainty relation is fulfilled after the observation. The position of the electron will be known with an accuracy given by the wave length of the y-ray. The electron may have been practically at rest before the observation. But in the act of observation at least one light quantum of the y-ray must have passed the microscope and must first have been deflected by the electron. Therefore, the electron has been pushed by the light quantum, it has changed its momentum and its velocity, and one can show that the uncertainty of this change is just big enough to guarantee the validity of the uncertainty relations. Therefore, there is no difficulty with the first step.

At the same time one can easily see that there is no way of observing the orbit of the electron around the nucleus. The second step shows a wave pocket moving not around the nucleus but away from the atom, because the first light quantum will have knocked the electron out from the atom. The momentum of light quantum of the y-ray is much bigger than the original momentum of the electron if the wave length of the e-ray is much smaller than the size of the atom. Therefore, the first light quantum is sufficient to knock the electron out of the atom and one can never observe more than one point in the orbit of the electron; therefore, there is no orbit in the ordinary sense. The next observation - the third step - will show the electron on its path from the atom. Quite generally there is no way of describing what happens between two consecutive observations. It is of course tempting to say that the electron must have been somewhere between the two observations and that therefore the electron must have described some kind of path or orbit even if it may be impossible to know which path. This would be a reasonable argument in classical physics. But in quantum theory it would be a misuse of the language which, as we will see later, cannot be justified. We can leave it open for the moment, whether this warning is a

statement about the way in which we should talk about atomic events or a statement about the events themselves, whether it refers to epistemology or to ontology. In any case we have to be very cautious about the wording of any statement concerning the behaviour of atomic particles.

Actually we need not speak of particles at all. For many experiments it is more convenient to speak of matter waves; for instance, of stationary matter waves around the atomic nucleus. Such a description would directly contradict the other description if one does not pay attention to the limitations given by the uncertainty relations. Through the limitations the contradiction is avoided. The use of 'matter waves' is convenient, for example, when dealing with the radiation emitted by the atom. By means of its frequencies and intensities the radiation gives information about the oscillating charge distribution in the atom, and there the wave picture comes much nearer to the truth than the particle picture. Therefore, Bohr advocated the use of both pictures, which he called 'complementary' to each other. The two pictures are of course mutually exclusive, because a certain thing cannot at the same time be a particle (i.e., substance confined to a very small volume) and a wave (i.e., a field spread out over a large space), but the two complement each other. By playing with both pictures, by going from the one picture to the other and back again, we finally get the right impression of the strange kind of reality behind our atomic experiments. Bohr uses the concept of 'complementarity' at several places in the interpretation of quantum theory. The knowledge of the position of a particle is complementary to the knowledge of its velocity or momentum. If we know the one with high accuracy we cannot know the other with high accuracy; still we must know both for determining the behaviour of the system. The space-time description of the atomic events is complementary to their deterministic description. The probability function obeys an equation of motion as the coordinates did in Newtonian mechanics; its change in the course of time is completely determined by the quantum mechanical equation, but it does not allow a description in space and time. The observation, on the other hand, enforces the description in space and time but breaks the determined continuity of the probability function by changing our knowledge of the system.

Generally the dualism between two different descriptions of the same reality is no longer a difficulty since we know from the mathematical formulation of the theory that contradictions cannot arise. The dualism between the two complementary pictures - waves and particles - is also clearly brought out in the flexibility of the mathematical scheme. The formalism is normally written to resemble Newtonian mechanics, with

equations of motion for the coordinates and the momenta of the particles.

But by a simple transformation it can be rewritten to resemble a wave equation for an ordinary three-dimensional matter wave. Therefore, this possibility of playing with different complementary pictures has its analogy in the different transformations of the mathematical scheme; it does not lead to any difficulties in the Copenhagen interpretation of quantum theory.

A real difficulty in the understanding of this interpretation arises, however, when one asks the famous question: But what happens 'really' in an atomic event? It has been said before that the mechanism and the results of an observation can always be stated in terms of the classical concepts. But what one deduces from an observation is a probability function, a mathematical expression that combines statements about possibilities or tendencies with statements about our knowledge of facts So we cannot completely objectify the result of an observation, we cannot describe what 'happens' between this observation and the next. This looks as if we had introduced an element of subjectivism into the theory, as if we meant to say: what happens depends on our way of observing it or on the fast that we observe it. Before discussing this problem of subjectivism it is necessary to explain quite clearly why one would get into hopeless difficulties if one tried to describe what happens between two consecutive observations.

For this purpose it is convenient to discuss the following ideal experiment: We assume that a small source of monochromatic light radiates toward a black screen with two small holes in it. The diameter of the holes may be not much bigger than the wave length of the light, but their distance will be very much bigger. At some distance behind the screen a photographic plate registers the incident light. If one describes this experiment in terms of the wave picture, one says that the primary wave penetrates through the two holes, there will be secondary spherical waves starting from the holes that interfere with one another, and the interference will produce a pattern of varying intensity on the photographic plate.

The blackening of the photographic plate is a quantum process, a chemical reaction produced by single light quanta. Therefore, it must also be possible to describe the experiment in terms of light quanta. If it would be permissible to say what happens to the single light quantum between its emission from the light source and its absorption in the photographic plate, one could argue as follows: The single light quantum can come through the first hole or through the second one. If it goes through the first hole and is scattered there, its probability for being absorbed at a

certain point of the photographic plate cannot depend upon whether the second hole is closed or open. The probability distribution on the plate will be the same as if only the first hole was open. If the experiment is repeated many times and one takes together all cases in which the light quantum has gone through the first hole, the blackening of the plate due to these cases will correspond to this probability distribution. If one considers only those light quanta that go through the second hole, the blackening should correspond to a probability distribution derived from the assumption that only the second hole is open. The total blackening, therefore, should just be the sum of the blackenings in the two cases; in other words, there should be no interference pattern. But we know this is not correct, and the experiment will show the interference pattern. Therefore, the statement that any light quantum must have gone either through the first or through the second hole is problematic and leads to contradictions. This example shows clearly that the concept of the probability function does not allow a description of what happens between two observations. Any attempt to find such a description would lead to contradictions; this must mean that the term 'happens' is restricted to the observation.

Now, this is a very strange result, since it seems to indicate that the observation plays a decisive role in the event and that the reality varies, depending upon whether we observe it or not. To make this point clearer we have to analyse the process of observation more closely.

To begin with, it is important to remember that in natural science we are not interested in the universe as a whole, including ourselves, but we direct our attention to some part of the universe and make that the object of our studies. In atomic physics this part is usually a very small object, an atomic particle or a group of such particles, sometimes much larger - the size does not matter; but it is important that a large part of the universe, including ourselves, does not belong to the object.

Now, the theoretical interpretation of an experiment starts with the two steps that have been discussed. In the first step we have to describe the arrangement of the experiment, eventually combined with a first observation, in terms of classical physics and translate this description into a probability function. This probability function follows the laws of quantum theory, and its change in the course of time, which is continuous, can be calculated from the initial conditions; this is the second step. The probability function combines objective and subjective elements. It contains statements about possibilities or better tendencies ('potentia' in Aristotelian philosophy), and these statements are completely objective, they do not depend on any observer; and it contains statements about our knowledge of the system, which of course are

subjective in so far as they may be different for different observers. In ideal cases the subjective element in the probability function may be practically negligible as compared with the objective one. The physicists then speak of a 'pure case'.

When we now come to 'the next observation. the result of which should be predicted from the theory, it is very important to realize that our object has to be in contact with the other part of-the world, namely, the experimental arrangement, the measuring rod, etc., before or at least at the moment of observation. This means that the equation of motion for the probability function does now contain the influence of the interaction with the measuring device. This influence introduces a new element of uncertainty, since the measuring device is necessarily described in the terms of classical physics; such a description contains all the uncertainties concerning the microscopic structure of the device which we know from thermodynamics, and since the device is connected with the rest of the world, it contains in fact the uncertainties of the microscopic structure of the whole world. These uncertainties may be called objective in so far as they are simply a consequence of the description in the terms of classical physics and do not depend on any observer. They may be called subjective in so far as they refer to our incomplete knowledge of the world.

After this interaction has taken place, the probability function contains the objective element of tendency and the subjective element of incomplete knowledge, even if it has been a 'pure case' before. It is for this reason that the result of the observation cannot generally be predicted with certainty; what can be predicted is the probability of a certain result of the observation, and this statement about the probability can be checked by repeating the experiment many times. The probability function does - unlike the common procedure in Newtonian mechanics - not describe a certain event but, at least during the process of observation, a whole ensemble of possible events.

The observation itself changes the probability function discontinuously; it selects of all possible events the actual one that has taken place. Since through the observation our knowledge of the system has changed discontinuously, its mathematical representation also has undergone the discontinuous change and we speak of a 'quantum jump'. When the old adage 'Natura non facit saltus' is used as a basis for criticism of quantum theory, we can reply that certainly our knowledge can change suddenly and that this fact justifies the use of the term 'quantum jump'.

Therefore, the transition from the 'possible' to the 'actual' takes place during the act of observation. If we want to describe what happens

in an atomic event, we have to realize that the word 'happens' can apply only to the observation, not to the state of affairs between two observations. It applies to the physical, not the psychical act of observation, and we may say that the transition from the 'possible' to the 'actual' takes place as soon as the interaction of the object with the measuring device, and thereby with the rest of the world, has come into play; it is not connected with the act of registration of the result by the mind of the observer. The discontinuous change in the probability function, however, takes place with the act of registration, because it is the discontinuous change of our knowledge in the instant of registration that has its image in the discontinuous change of the probability function.

To what extent, then, have we finally come to an objective description of the world, especially of the atomic world? In classical physics science started from the belief - or should one say from the illusion? - that we could describe the world or at least parts of the world without any reference to ourselves. This is actually possible to a large extent. We know that the city of London exists whether we see it or not. It may be said that classical physics is just that idealisation in which we can speak about parts of the world without any reference to ourselves. Its success has led to the general ideal of an objective description of the world. Objectivity has become the first criterion for the value of any scientific result. Does the Copenhagen interpretation of quantum theory still comply with this ideal? One may perhaps say that quantum theory corresponds to this ideal as far as possible. Certainly quantum theory does not contain genuine subjective features, it does not introduce the mind of the physicist as a part of the atomic event. But it starts from the division of the world into the 'object' and the rest of the world, and from the fact that at least for the rest of the world we use the classical concepts in our description. This division is arbitrary and historically a direct consequence of our scientific method; the use of the classical concepts is finally a consequence of the general human way of thinking. But this is already a reference to ourselves and in so far our description is not completely objective.

It has been stated in the beginning that the Copenhagen interpretation of quantum theory starts with a paradox. It starts from the fact that we describe our experiments in the terms of classical physics and at the same time from the knowledge that these concepts do not fit nature accurately. The tension between these two starting points is the root of the statistical character of quantum theory. Therefore, it has sometimes been suggested that one should depart from the classical concepts altogether and that a radical change in the concepts used for

describing the experiments might possibly lead back to a non-statical, completely objective description of nature.

This suggestion, however, rests upon a misunderstanding. The concepts of classical physics are just a refinement of the concepts of daily life and are an essential part of the language which forms the basis of all natural science. Our actual situation in science is such that we do use the classical concepts for the description of the experiments, and it was the problem of quantum theory to find theoretical interpretation of the experiments on this basis. There is no use in discussing what could be done if we were other beings than we are. At this point we have to realize, as von Weizsäcker has put it, that 'Nature is earlier than man, but man is earlier than natural science.' The first part of the sentence justifies classical physics, with its ideal of complete objectivity. The second part tells us why we cannot escape the paradox of quantum theory, namely, the necessity of using the classical concepts.

We have to add some comments on the actual procedure in the quantum-theoretical interpretation of atomic events. It has been said that we always start with a division of the world into an object, which we are going to study, and the rest of the world, and that this division is to some extent arbitrary. It should indeed not make any difference in the final result if we, e.g., add some part of the measuring device or the whole device to the object and apply the laws of quantum theory to this more complicated object. It can be shown that such an alteration of the theoretical treatment would not alter the predictions concerning a given experiment. This follows mathematically from the-fact that the laws of quantum theory are for the phenomena in which Planck's constant can be considered as a very small quantity, approximately identical with the classical laws. But it would be a mistake to believe that this application of the quantum-theoretical laws to the measuring device could help to avoid the fundamental paradox of quantum theory.

The measuring device deserves this name only if it is in close contact with the rest of the world, if there is an interaction between the device and the observer. Therefore, the uncertainty with respect to the microscopic behaviour of the world will enter into the quantum-theoretical system here just as well as in the first interpretation. If the measuring device would be isolated from the rest of the world, it would be neither a measuring device nor could it be described in the terms of classical physics at all.

With regard to this situation Bohr has emphasised that it is more realistic to state that the division into the object and the l rest of the world is not arbitrary. Our actual situation in research work in atomic physics is usually this: we wish to understand a l certain phenomenon, we

wish to recognise how this phenomenon follows from the general laws of nature. Therefore that part of matter or radiation which takes part in the phenomenon is the natural 'object' in the theoretical treatment and should be separated in this respect from the tools used to study the phenomenon. This again emphasises a subjective element in the description of atomic events, since the measuring device has been constructed by the observer, and we have to remember that what we observe is not nature in itself but nature exposed to our method of questioning. Our scientific work in physics consists in asking questions about nature in the language that we possess and trying to get an answer from experiment by the means that are at our disposal. In this way quantum theory reminds us, as Bohr has put it, of the old wisdom that when searching for harmony in life one must never forget that in the drama of existence we are ourselves both players and spectators. It is understandable that in our scientific relation to nature our own activity becomes very important when we have to deal with parts of nature into which we can penetrate only by using the most elaborate tools.

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