Natural Theology
or
Evidences of the Existence and Attributes of the Deity
collected from the appearances of nature

William Paley

1802

[Brackets] enclose editorial explanations. Small ·dots· enclose material that has been added, but can be read as though it were part of the original text. Occasional •bullets, and also indenting of passages that are not quotations, are meant as aids to grasping the structure of a sentence or a thought. In other texts on the website from which this one comes, four-point ellipses . . . . are used to indicate the omission of brief passages; in the present text such omissions are not noted, as there are too many of them. Paley was in many ways an excellent stylist, but he was enormously prolix, mostly through repetitions, which have been stripped out. Long omissions are reported between brackets in normal-sized type. —Paley provides dozens of references to works of anatomy, natural history, theology etc., which are omitted from the present version. —The division into numbered chapters is Paley's; some of the chapter-titles are not; and the division into unnumbered sections is not.

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Contents

Glossary

affect: As used in one paragraph on pages 75–76 this means 'be drawn to, have something like a desire for'. Paley seems to use it as the verb cognate with the noun 'appetency'.

appetency: A propensity or tendency to go after something. Broader in meaning than 'desire' or 'appetite', but sufficiently related to them for Paley to say on page 76 that the term can't be transferred from animals to plants.

art: Paley mainly uses this to refer to human skill, until page 44, after which the skill in question is sometimes God's or (the same thing, for Paley) nature's.

artificial: Made with skill. Quite often, the skill is God's.

artist: A human being who uses skill in making something. A watch-maker is an 'artist' even if there is nothing 'artistic', in our sense, about the watch. Similarly 'artificer'.

brute: sub-human animal, not necessarily 'brutal' or 'brutish' (as we would say).

contrivance: One of Paley's favourite words, it is equivalent to 'design'.

curious: Paley's meaning for this seems to be somewhere in the region of three of the OED's senses for it: 'exquisite, excellent, fine', 'interesting, noteworthy', 'deserving or arousing curiosity; strange, queer'.

elements: Paley uses this term mainly to refer to the traditional four: earth, air, fire, water. In chapter 21 ('Elements'), however, earth drops out; and both there and in chapter 17 light is included, as 'this new, this singular element'.

evil: bad. In early modern times it did not have as strenuous a meaning as it does today. Especially when used as a noun: 'the origin of evil' means 'the explanation of why there is anything bad in the universe'; a toothache would count as an evil.

faculty: Capacity, ability.

final cause: Goal, end aimed at, purpose. Paley uses the phrase quite often, but, oddly, not before page 37.

imperfection: When Paley speaks of the imperfection of some part of our knowledge (e.g. of chemistry) he means its incompleteness, its not yet being finished. Especially in chapter 7. In 'the evils of imperfection' (pages 88–89) the word means something more like what we mean by it today.

industry: work.

instrument: When on page 10 and elsewhere Paley insists that certain biological items are 'instruments', he means that they don't design anything; they are like the chisel, not the carpenter.

office: In Paley's day, a thing's 'office' was its role or function in some scheme of things. Similarly for the 'office' of a person.

original: An original feature of an organism is one that it had from the outset, not something it acquired later.

principle: Paley sometimes uses this word in a now-obsolete sense in which it means 'source', 'cause', 'driver', 'energizer', or the like. The phrase 'principle of order', which he mocks on pages 2 and 14, means 'something bringing it about that there is order in the world'.

probation: Testing someone's character, especially with a view to his fitness for the after-life.

second causes: intermediate causes, between God (the first cause) and whatever effects we are interested in.

station: Social standing, rank.

subservient: Serving as a means to an end (OED). Similarly 'subservience'.

1. The basic argument

Suppose that in crossing a meadow I pitched my foot against a stone, and were asked how the stone came to be there; I might answer that for all I knew to the contrary it had lain there for ever, and it might not be very easy to show the absurdity of this answer. But suppose I had found a watch on the ground, and it was asked how the watch happened to be in that place; I would hardly think of the answer that for all I knew it might have always been there. But why should this answer not serve for the watch as well as for the stone? For this and no other reason: when we inspect the watch we perceive (what we could not discover in the stone) •that its various parts are shaped and put together for a purpose, i.e. •that they are formed and adjusted so that they move, and that motion is regulated so as to point out the hour of the day; •that if the different parts had been different in shape, size, or relations to one another, either no motion would have occurred in the machine, or none that would have answered the use that is now served by it. To reckon up a few of the plainest of these parts, and of their offices [see Glossary], all tending to one result:

- •A cylindrical box containing a coiled elastic spring, which by its attempt to relax itself turns around the box.
- •A flexible chain communicating the action of the spring from the box to the fusee.
- •A series of wheels, the teeth of which engage with one another, conducting the motion from the fusee to the balance, and from the balance to the pointer; and at the same time, by the size and shape of those wheels, regulating that motion in such a way that an evenly moving pointer passes over a given space in a given time.
- •The wheels are made of brass in order to keep them from rust; the springs of steel, no other metal being so elastic.
- •Over the face of the watch there is placed a glass, a material employed in no other part of the work, its transparency being needed so that the hour could be seen without opening the case.

To see and understand all this requires an examination of the instrument and perhaps some previous knowledge of the subject; but once it has been observed and understood, the inference seems inevitable that **the watch must have had a maker**: there must have existed, at some time and some place an artificer or artificers who formed it for the purpose which we find it actually to answer, who understood its construction and designed its use.

(1) I do not think it would weaken the conclusion if we had never seen a watch made, had never known an artist [see Glossary] capable of making one, could not possibly carry out such a piece of workmanship ourselves or even understand how it was performed. All this is no more than what is true of some exquisite remains of ancient art, of some lost arts, and—to most people—of the more curious [see Glossary] productions of modern manufacture. Does one man in a million know how lathes are used to produce oval picture-frames? Ignorance of this kind raises our opinion of the unknown artist's skill if he *is* unknown, but it creates no doubt in our minds of the existence and agency of such an artist at some former time and in some place. Nor can I see that it makes any difference to the inference whether it concerns a human agent, an agent of a different species, or an agent possessing in some respects a different nature.

(2) Nor would it invalidate our conclusion if the watch sometimes went wrong or seldom went exactly right. The purpose of the machinery, the design, and the designer might be evident—and in the case of the watch *would* be evident—however we accounted for the irregularity of the movement, or whether we could account for it or not. A machine does not have to be perfect in order to show with what design it was made, let alone showing that it was made with some design.

(3) The argument would not be weakened if there were **(i)** a few parts of the watch concerning which we could not discover, or had not yet discovered, how they contributed to the general effect; or even **(ii)** some parts concerning which we could not ascertain whether they contributed to that effect at all. For, as regards **(i)**, if by the loss or disorder or decay of the parts in question the movement of the watch were stopped or disturbed or retarded, no doubt would remain in our minds as to the utility or intention of those parts, even if we could not investigate *how* the ultimate effect depended on their action or assistance; and the more complex the machine, the more likely this obscurity is to arise. As regards **(ii)** the supposition that there were parts that could be spared without prejudice to the movement of the watch, and that we had proved this by experiment: these superfluous parts, even if we were completely assured that they were such, would not cancel our reasoning concerning other parts. The indication of contrivance [see Glossary] remained, with respect to them, nearly as it was before.

(4) No man in his senses would think the existence of the watch accounted for by being told that it was one out of the possible combinations of material forms; that whatever he had found in that place must have contained *some* internal configuration, and that this configuration might as well be the structure now exhibited—namely of the works of a watch—as a different structure.

(5) Nor would it yield his inquiry more satisfaction to be told that there is in things a principle [see Glossary] of order that had disposed the parts of the watch into their present form and situation. He never knew a watch made by the principle of order; nor can he even form to himself an idea of what is meant by 'principle of order' other than the mind of the watch-maker.

(6) He would be surprised to hear that the mechanism of the watch was no proof of contrivance, only something that induces the mind to think so.

(7) . . . and not less surprised to be informed that the watch is nothing more than the result of the laws of metallic nature. It is a perversion of language to assign any *law* as the efficient, operative cause of anything. A law presupposes an agent, for it is only the way in which an agent proceeds; it implies a power, for it is the order according to which that power acts. This agent and this power are distinct from the law itself, and without them the law does nothing, is nothing. [Paley adds that the more familiar 'law of vegetable nature', 'law of animal nature', and 'law of nature' are just as disreputable as 'law of metallic nature' when any of these laws is taken to be the *cause* of something, leaving out agency and power.]

(8) Nor would our observer be driven out of his conclusion, or from his confidence in its truth, by being told that he knew nothing at all about the matter. He knows enough for his argument: he knows the usefulness of the end; he knows the subservience [see Glossary] and adaptation of the means to the end. These points being known, his ignorance of other points (or doubts concerning other points) do not affect the certainty of his reasoning. Awareness of knowing little need not make him distrust what he does know.

2. Watch producing watch

Continuing the basic argument: suppose now that the person who found the watch discovered later that in addition to all the properties he had observed it to have, it also had the unexpected property of producing in the course of its movement another watch like itself. Suppose, as is conceivable, that it contained within it a mechanism—a mould or a complex system of lathes, files, and other tools—evidently and separately calculated for this purpose. What effect ought this to have on his former conclusion?

(1) The first effect would be to increase his admiration of the contrivance, and his belief in the consummate skill of the contriver This new observation would give him nothing but an additional reason for doing what he had already done, namely for referring the construction of the watch to design and to supreme art. If, before this property had been noticed, that construction proved intention and art to have been employed in it, the proof would appear still stronger when he came to the knowledge of this further property, the crown and perfection of all the rest.

(2) He would reflect that although the watch before him was in some sense the *maker* of the watch that was fabricated in the course of its movements, this was in a very different sense from that in which, for instance, a carpenter is the *maker* of a chair, namely the author of its contrivance, the cause of the relation of its parts to their use. With respect to these, the first watch was no cause at all to the second: it was not the author of the constitution and order of the parts the new watch contained, or of the parts by the aid and instrumentality of which it was produced. We might possibly say, using words very broadly, that a river ground corn; but no broadness of language would allow us to say—and no stretch of conjecture could lead us to think—that the river built the mill, even if the mill was too ancient for us to know who the builder was. What the river does in the affair is just this: by the application of an unthinking impulse to a mechanism previously arranged—arranged independently of it, by something thinking—an effect is produced, namely the corn is ground. But the effect results from the arrangement. The force of the river cannot be said to be the cause or author of the effect, still less of the arrangement. The river's share in grinding the corn does not detract from the need for understanding and plan in the formation of the mill; and this applies to the watch's share in the production of the new watch, on the supposition we are now exploring.

(3) So even if it is now no longer probable that the individual watch that our observer found was made •immediately by the hand of an artificer, this has no effect on the inference that an artificer was •originally involved in the production. The argument from design remains as it was. Marks of design and contrivance are no more accounted for now than before. We can ask for the cause of a thing's different properties—of its colour, its hardness, its heat—and these causes may be all different. We are now asking for the cause of that subservience to a use, that relation to an end, that we saw in the watch in our hand; and this question is not answered by the statement that a preceding watch produced it. There can't be

- •design without a designer,
- •contrivance without a contriver,
- •order without choice,
- •arrangement without anything capable of arranging,
- •subservience and relation to a purpose without something that could intend a purpose,
- •means suitable to an end, and executing their office in accomplishing that end, without the end having been contemplated, or the means made to fit it.

Arrangement, disposition of parts, subservience of means to an end, relation of instruments to a use, imply the presence of intelligence and mind. No-one, therefore, can rationally believe that the unthinking inanimate watch from which the watch before us issued •was the proper cause of the mechanism we so much admire in it, i.e. •could be truly said to have constructed the instrument, disposed its parts, assigned their office, determined their order, action, and mutual dependency, combined their various motions into one result that is connected with the utilities of other beings. So all these properties are as much unaccounted for as they were before.

(4) Nor is anything gained by running the difficulty further back, i.e. by supposing this watch to have been produced from another watch, that from a former one, and so on indefinitely. However far back we go, that will bring us no nearer to any satisfaction on the subject. Contrivance is still not accounted for; we still lack a contriver; a designing mind is not provided by this supposition, nor is it shown not to be needed. If the difficulty grew less the further back we went, we might by going back indefinitely remove it altogether. Where as we increase the number of terms there is a tendency (or continual approach) towards a limit, there by supposing the number of terms to be what is called ‘infinite’ we may conceive the limit to be reached; but where there is no such tendency or approach, nothing is achieved by lengthening the series. There is no difference in our present context (whatever there may be in many others) between a finite series and an infinite series; a chain composed of an infinite number of links can no more support itself than can a chain composed of a finite number of links. And of this we are assured (though we never can have tried the experiment), because by increasing the number of links from 10 to 100, say, or from 100 to 1,000, we do not observe the smallest tendency (make the smallest approach) towards self-support. The machine we are inspecting demonstrates by its construction *contrivance* and *design*. contrivance must have had a contriver; design, a designer; whether the machine immediately came from another machine or not. [He spells the point out again: however far back we go in the sequence of machine-producing machines, the requirement for a designer remains in full force.]

The question is not simply ‘How did the first watch come into existence?’. It may be claimed that *that* question is disposed of by supposing the series of watch-producing watches to have been infinite, and consequently to have had no first member for which a cause must be provided. This might have been nearly the state of the question if nothing had been before us but an unorganised, unmechanised substance with no indication of contrivance. It might be difficult to show that this could not have existed from eternity, either •in succession (if unorganised bodies could arise from one another, which I do not think they could) or •by individual perpetuity [i.e. by there being one body that has always existed, never began]. But that is not the question now. The watch we are examining manifests contrivance, design; an end, a purpose; means for the end, adaptation to the purpose. And the question that irresistibly presses on our thoughts concerns the origin of this contrivance and design. The thing required is the intending mind, the adapting hand, the intelligence by which that hand was directed; and this demand is not shaken off by increasing a number or succession of substances, even by increasing that number to infinity. That increase still leaves us with contrivance but no contriver, proofs of design but no designer.

(5) Our observer would also reflect that the maker of the watch before him was really the maker of every watch produced from it. As between

(i) making another watch with his own hands, by the mediation of files, lathes, chisels, etc. and

(ii) disposing, fixing, and inserting these instruments in the body of the watch already made in such a way as to produce a new watch in the course of the movements he had given to the old one

there is no difference except that **(ii)** manifests a more exquisite skill. As for the view that the discovery of the watch-producing watch, rather than increasing our admiration of the skill involved, should turn us round to the opposite conclusion that no art or skill has been concerned in the business; it is simply absurd. Yet this is atheism.

3. Applying the argument: eye & telescope

This is atheism: for every indication of contrivance, every manifestation of design that existed in the watch exists in the works of nature; with the difference that in nature they are incalculably greater. I mean that the contrivances of nature surpass the contrivances of art in the complexity, subtlety and curiosity of the mechanism; and in their number and variety; yet in many cases they are at least as obviously •mechanical, •contrivances, •adjusted to their end, as are the most perfect productions of human ingenuity.

I know no better method of introducing so large a subject than to compare one single thing with another, e.g. an eye with a telescope. As far as the examination of the instrument goes, there is precisely the same proof that the eye was made for vision as that the telescope was made for assisting it. They are made on the same principles, both being adjusted to the laws governing the transmission and refraction of light. Those laws, whatever their origin, are *fixed*, and the construction in both cases is adapted to them. For instance:

> These laws require that if the same effect is to be produced, the rays of light passing from water into the eye should be refracted by a more convex surface than when passing out of air into the eye. And we find that the crystalline lens in the eye of a fish is much rounder than in the eye of terrestrial animals.

What plainer manifestation of design can there be than this difference? What more could an instrument-maker have done to show his knowledge of his principle, his application of that knowledge, his suiting of his means to his end?

To some it may appear that the eye is not comparable with the telescope because one is a perceiving organ and the other an unperceiving instrument. In fact they are both instruments; and the kind of mechanism employed in both is the same. ·I shall now show this·.

Observe what the constitution of the eye is. To produce clear vision an image or picture of the object must be formed at the bottom of the eye. Why this is required, or how the picture is connected with the sensation may be difficult or even impossible for us to find out; but that is irrelevant to the present question. It may be true that in some cases we trace mechanical contrivance a certain way and then come to something that is not mechanical, or that is inscrutable; but this does not affect the certainty of our investigation as far as it has gone. The difference between an animal and an automatic statue [= 'robot'] is this:

- •in the animal we trace the mechanism to a certain point and then we are stopped; either the mechanism becomes too subtle for our discernment, or something other than the known laws of mechanism comes to be involved, whereas
- •in the automaton, for the few motions of which it is capable, we trace the mechanism throughout.

But up to that limit, the reasoning is as clear and certain in the one case as in the other. In the example before us, it is a matter of certainty—demonstrated by experience and observation—that the formation of an image at the bottom of the eye is necessary to perfect vision. The formation of such an image being necessary (no matter how) to the exercise of the sense of sight, the apparatus by which it is formed is put together not only with infinitely more art but on the self-same principles of art as in the telescope or the camera obscura. The perception arising *from* the image is not in question here; for the production *of* the image these are instruments of the same kind: they are alike in their end and the means to it. The lenses of the telescope and the humours of the eye are exactly alike in their shape, their position, and their power to bring each pencil of light-rays to a point at the right distance from the lens, namely (in the eye) at the exact place where the membrane is spread to receive it. With such close similarity, how is it possible to exclude contrivance from the one yet to acknowledge the proof of contrivance having been employed, as the plainest and clearest of all propositions, in the other?

The resemblance between the two cases obtains in more points than those I have mentioned, indeed more than we are, on our first view of the subject, even aware of. In dioptric telescopes, there is this imperfection: pencils of light in passing through glass lenses are separated into different colours, thereby tinting the object, especially its edges, as if it were viewed through a prism. A correction of this inconvenience was long desired by opticians. At last it occurred to one sagacious optician to inquire how this matter was managed in the eye, where there was exactly the same difficulty to contend with as in the telescope. He found that in the eye the trouble was fixed by combining lenses composed of different substances, i.e. substances with different refracting powers. He took his hint, and produced a correction of the defect by imitating, in glasses made from different materials, the effects of the different humours through which the light-rays pass en route to the bottom of the eye. Could this be in the eye without purpose—this system that suggested to the optician the only effective means of attaining that purpose?

The eye's superiority to the telescope

There are also ways in which the eye is superior to the telescope. Two things were needed for the eye that were not needed (at least in the same degree) for the telescope: the adaptation of the organ **(1)** to different degrees of light and **(2)** to the vast diversity of distance—from a few inches to as many miles—at which objects are viewed by the naked eye. These are not difficulties for the maker of the telescope. He wants all the light he can get; and he never directs his instrument to objects near at hand. In the eye, each difficulty is provided for by a subtle and appropriate mechanism.

(1) In order to exclude excess of light when it is excessive, and to make objects visible when there is less light, the hole or aperture in the eye through which the light enters is so formed as to contract or dilate itself for the purpose of admitting more or fewer rays at the same time. The chamber of the eye is a camera obscura which when the light is too small can enlarge its opening, when too strong can again contract it, without any assistance but that of its own exquisite machinery. Observe also that in the human subject this hole in the eye (we call it the 'pupil') through all its changes of size retains its exact circular shape. If an artist [see Glossary] tries to achieve this he will find that his threads and strings must be disposed with great care and contrivance, to make a circle that continually changes its diameter but keeps its shape. This is done in the eye by an application of fibres similar in their position and action to what an artist would have to employ if he had the same piece of workmanship to perform.

(2) The second difficulty was that of suiting the eye to the perception of objects near at hand and of objects at a considerable distance. According to the principles of optics—i.e. the fixed laws by which the transmission of light is regulated—this could not be done without an alteration in the eye itself, affecting the angles to one another at which the light-rays reached it. Rays issuing from points close to the eye must enter the eye in a spreading or diverging order; rays from objects situated much further away arrive at the eye nearly parallel; the two cannot—by the same optical instrument in the same state—be brought to a point, i.e. be made to form an image, in the same place. Well, it has recently been found that when the eye is directed to a near object three changes occur that jointly contribute to the adjustment required. •The cornea or outermost coat of the eye is made more round and prominent; •the crystalline lens underneath is pushed forward; and •the axis of vision (as the depth of the eye is called) is elongated. These changes in the eye vary its power over the rays of light in such a way as to produce exactly the desired effect, namely the formation of an image on the retina, whether the rays come to the eye angled to one another or parallel to one another. Can anything be more decisive of contrivance than this is? The most secret laws of optics must have been known to the author of a structure having such a capacity for change.

[Paley exclaims about how these wonders are present in the eyes of a new-born child; then describe variations in different animal species, reflecting differences in needs and life-styles. E.g. birds' eyes get special help to make the changes needed for seeing things very close up and very far away; comparable points about fishes, and eels. Then:]

Other wonders of the eye

In considering vision as achieved by the means of an image formed at the bottom of the eye, we must wonder at the smallness yet correctness of the picture, the subtlety of the touch, the fineness of the lines. A landscape of five or six square leagues is brought into a space of half an inch diameter; yet the multitude of objects that it contains are all preserved, all distinguished in their sizes, positions, shapes, colours. The prospect from Hampstead hill is compressed into the area of a sixpence, yet represented in detail. A stage coach travelling at its ordinary speed for half an hour passes, in the eye, over only one-twelfth of an inch; yet this change of place in the image is distinctly perceived throughout its whole progress, for it is only by means of that perception that the motion of the coach itself is made sensible to the eye. If anything can lessen our admiration of the smallness of the visual tablet compared with the extent of vision, it is the reflection—to which we are constantly led by the view of nature—that in the hands of the Creator the difference between great and little is nothing.

Sturmius held that the examination of the eye was a cure for atheism. Everything belonging to it and about it shows an extraordinary degree of care, an anxiety for its preservation, because of its value and its tenderness. It is lodged in a strong, deep, bony socket, composed by the junction of seven different bones, hollowed out at their edges. Within this socket it is embedded in fat, of all animal substances the best adapted both to its repose and its motion. It is sheltered by the eyebrows; an arch of hair which like a thatched penthouse prevents the sweat and moisture of the forehead from running down into it.

But it is still better protected by its lid. Of the superficial parts of the animal frame, I know none which in its office and structure is more deserving of attention than the eyelid. It defends the eye; it wipes it; it closes it in sleep. Does any work of art exhibit purposes more evident than the ones the eyelid fulfils? or a more intelligible, more appropriate, or more mechanical apparatus for achieving those purposes? If it is overlooked by the observer of nature, that can only be because it is obvious and familiar. This is a tendency to be guarded against.

[Paley now **(i)** writes for half a page about the tear-glands' role in 'keeping the eye moist and clean', which fish do not have because they do not need it; and **(ii)** devotes two pages to 'that most exquisite of all contrivances, the nictitating membrane, which is found in the eyes of birds and of many quadrupeds', its role being to spread tears over the eye and also defend it from sudden injuries. He at length describes and praises the mechanism by which this works; and then moves on to a good theological question.]

Why would an omnipotent God make mechanisms?

One question may have dwelt in the reader's mind while reading these observations, namely *Why did not the Deity give the animal the faculty [see Glossary] of vision at once?* Why this circuitous perception?

> The employment of so many means: an element provided for the purpose reflected from opaque substances and refracted through transparent ones, both according to precise laws; then a complex organ, an intricate and artificial [see Glossary] apparatus, in order—by the operation of this element and in conformity with these laws—to produce an image on a membrane communicating with the brain?

Why all this? Why make the difficulty in order to overcome it? If what was wanted was for the animal to perceive objects in some way other than by touch, or to perceive objects that lay out of the reach of that sense, could not a simple volition of the Creator have conferred that ability? Why resort to contrivance where power is omnipotent? contrivance, by its very definition and nature, is the refuge of imperfection. To have recourse to expedients implies difficulty, impediment, restraint, defect of power. This question arises for the other senses as well as sight; to the general functions of animal life, as nutrition, secretion, respiration, to the economy of vegetables, and indeed to almost all the operations of nature. So the question is of very wide extent. Among other answers that may be given to it—beside ones of which probably we are ignorant—one is this: *It is only by the display of contrivance that the existence, agency, and wisdom of the Deity could be testified to his rational creatures.* This is the ladder by which we ascend to all the knowledge of our Creator that we have, so far as it depends on the phenomena, the works of nature. Take away this and you deprive us of every subject of observation and ground of reasoning—I mean as our rational faculties are formed at present. Whatever is done, God could have done without the intervention of instruments or means; but it is in the construction of instruments, in the choice and adaptation of means, that a creative intelligence is seen. This is what constitutes the order and beauty of the universe. God, therefore, has chosen to prescribe limits to his own power, and to achieve his end within those limits. The general laws of matter perhaps set these limits:

- its inertia, its re-action,
- the laws governing the communication of motion,
- the refraction and reflection of light,
- the constitution of fluids, non-elastic and elastic,
- the transmission of sound through the latter,
- the laws of magnetism, of electricity,
- and probably other laws not yet discovered.

These are general laws; and when a particular purpose is to be effected it is not by making a new law, or suspending the old ones, or by making them wind and bend and yield to the occasion (for nature with great steadiness adheres to and supports them). Rather, the purpose is achieved, as we have seen in the eye, by the interposition of an apparatus that corresponds to these laws and satisfies the need that results from them. As I have said, therefore, God prescribes limits to •his power so as to make room for the exercise—and thereby exhibit demonstrations of—•his wisdom. It is as though one Being fixed certain rules and provided certain materials; and then gave another Being the task of drawing forth a creation out of these materials in obedience to these rules; a supposition which obviously leaves room for contrivance and indeed creates a necessity for it. I do not advance this as a doctrine either of philosophy or of religion; but I say that the subject can safely be looked at in this way, because the Deity acting himself by general laws will have the same effect on our reasoning as if he had prescribed these laws to another. It has been said that the problem of creation was: 'Attraction and matter being given, to make a world out of them'; and the explanation I have just given implies that this statement perhaps does not convey a false idea.

I have chosen the eye as an instance on which to rest the argument of this chapter. Some single example was to be proposed: and the eye offered itself under the advantage of admitting of a strict comparison with optical instruments. The ear is probably as artificially and mechanically adapted to its office as the eye is. But we know less about it: we do not so well understand the action, the use, or the mutual dependency of its internal parts. Its general form, however, both external and internal, is sufficient to show that it is an instrument adapted to the reception of sound; that is to say, already knowing that sound consists in pulses of the air, we perceive in the structure of the ear a suitableness to receive impressions from this kind of action and to propagate these to the brain. [Paley continues thus for several pages.]

4. The succession of plants and animals

Animals are the offspring of preceding animals, but this does not account for the contrivance [see Glossary] of the eye or ear; any more than—on the chapter 2 supposition—the production of a watch by the motion and mechanism of a former watch would account for the skill and intention evidenced in the watch so produced. I do insist on the correctness of this comparison: it holds for every kind of species propagation; whatever was true of the watch on the above-mentioned supposition is true of plants and animals.

(1) To begin with plants: can it be doubted that the seed contains a particular organisation, whatever its details may be, that is suited to the germination of a new plant? Has the plant that produced the seed anything more to do with that organisation than the watch would have to do with the structure of the watch that it mechanically produced? I mean, has it anything to do with the *contrivance*? Can any distinction be assigned between the producing watch and the producing plant; both passive, unconscious substances; both by the organisation that was given to them producing their like, without understanding or design; both, that is, *instruments*?

(2) From plants we may proceed to oviparous animals, from seeds to eggs. The bird has no more concern in the formation of the egg she lays than the plant has in that of the seed it drops. The internal constitution of the egg is as much a secret to the hen as if the hen were inanimate.

Her will cannot change a single feather of the chick. She can neither foresee nor determine of which sex her brood will be, or how many of either. So far from adapting the means, therefore, she does not know in advance what the effect will be. If concealed within that smooth shell there is a provision and a preparation for the production and nourishment of a new animal, they are not of her providing or preparing; if there is contrivance, it is none of hers. So the differences between the animal and the plant are irrelevant to my topic. Neither the one nor the other has to its offspring the sort of relation that a joiner does to the chair he makes. But *that* relation between cause and effect is what we want, to account for the suitableness of means to an end, the fitting of one thing to another; and this cause the parent plant or animal does not supply.

Notice also that the apparatus employed exhibits no resemblance to the thing produced, and are analogous in this respect to instruments [see Glossary] and tools of art. The filaments, anthers and stigmata of flowers are no more like the young plant (or even the seed) formed by their intervention than a chisel or a plane is like a table or chair. What, then, are the filaments etc. of plants but *instruments* strictly so called?

(3) We may advance from animals that bring forth eggs to ones that bring forth their young alive, and of these moving up the scale from brutes [see Glossary] to the human species, without perceiving any alteration in the terms of the comparison. The rational animal does not produce its offspring with more certainty or success than the irrational animal, a man than a quadruped, a quadruped than a bird. So rationality has nothing to do in the business. The parent is the cause of his offspring in the same sense as that in which a gardener is the cause of the tulip that grows on his parterre, and in no other. We admire the flower; we examine the plant; we perceive the conduciveness of many of its parts to their end and office; we observe a provision for its nourishment, growth, protection, and fecundity; but we never think of the gardener in all this, though it may be true that without the gardener we would not have had the tulip. The human parent is not the contriver of the structure of the offspring, as is shown by his state of mind: he is in total ignorance of why what is produced took its present form rather than any other; he is astonished by the effect. So we can no more look to •the intelligence of the parent animal for a cause of the means-end relation we see in the procreated body than we can refer the internal conformation of an acorn to •the intelligence of the oak from which it dropped, or the structure of the watch to •the intelligence of the watch that produced it. So far as this argument is concerned, there is no difference between an intelligence that is not exerted and an intelligence that does not exist.

5. Seven more points

Everything I said in chapter 1 about the watch can be repeated with strict propriety about the eye, about animals, about plants, indeed about all the organised parts of the works of nature. Thus:-

(1) When we are inquiring simply into whether something had an intelligent creator, there may be a considerable degree of imperfection, inaccuracy, liability to disorder, occasional irregularities, without bringing any doubt into the question; just as a watch may frequently go wrong, seldom perhaps exactly right; may be faulty in some parts, defective in some; without causing the slightest suspicion that it is not a watch, was not made, or was not made for the purpose ascribed to it. [Paley describes some of the moves we can make in such a case to prevent these faults from counting against 'the skill of the artist', and then sets all this aside.] These are different questions from the question of the artist's existence, i.e. of whether the thing before us is a work of art or not. Similarly with the works of nature: irregularities and imperfections are of little or no weight in considering the question of the existence of a Creator. When the question concerns his attributes, they *are* of weight; but [and then he lays out reasons why we should conclude that the 'apparent blemishes'] ought to be referred to some cause, though we are ignorant of it, other than defect of knowledge or of benevolence in the author.

(2) There may be also parts of plants and animals of which the **(a)** operation or the **(b)** use is unknown. These are different cases, for the operation may be unknown while the use is certain. **(a)** Thus it is with the lungs of animals. We are not acquainted with the action of the air on the blood, or with how that action is communicated by the lungs; but we find that a very short suspension of the lungs' office [see Glossary] destroys the life of the animal. So this is a case where we know the use—indeed, experience the necessity—of the organ, though we are ignorant of its operation. Somewhat similarly with the lymphatic system. **(b)** There may also be examples of the second kind, where not only the operation is unknown but experiments seem to show that the part is not necessary, or leave a doubt as to how far it is even useful to the plant or animal in which it is found. This is said to be the case with the spleen, which has been extracted from dogs without any perceptible injury to their vital functions.

Instances where **(a)** we cannot explain the operation may be numerous, for they will be so in proportion to our ignorance. They will be more or fewer to different persons, and in different stages of science. Every improvement of knowledge reduces their number; hardly a year goes by when some previously undiscovered and probably unsuspected operation or mode of operation does not come to light. Instances where **(b)** the part appears to be totally useless are extremely rare, I believe. [And, he goes on to say, it remains to be soundly shown that there are *any* such, concluding that even if it *were* shown,] these superfluous parts do not negate my reasoning concerning the parts that are useful, and of which we know the use. With respect to them, the indication of contrivance remains as it was before.

(3) One atheistic way of replying to my observations on the works of nature, and to the proofs of a Deity that I think I perceive in them, is to say:

> Everything we see must necessarily have had *some* form, and it might as well be its present form as any other.

Let us now apply this answer to the eye, as I did before to the watch. Something must have occupied that place in the animal's head; must have filled up, we will say, that socket. We will say also that it must have been of the sort we call 'animal substance', such as flesh, bone, membrane, cartilage, etc. But that it should have been an eye, knowing as we do what an eye comprehends—namely that it should have consisted of

- a series of transparent lenses,
- a black cloth or canvas spread out behind these lenses, so as to receive the image formed by pencils of light transmitted through them,
- a large nerve connecting this membrane with the brain, without which the action of light on the membrane would be lost to the purposes of sensation—

and that this fortunate conformation of parts should have been found in thousands of species of animals, that all this should have taken place, merely because something must have occupied those points in every animal's forehead—or that all this should be thought to be accounted for by the short answer that 'whatever was there must have had some form or other', is too absurd for me to make it more so! Indeed, it fails even when applied to appearances of organisation far short of those of the eye, such as we observe in fossil shells, petrified bones and the like, which may seem accidental enough in respect of utility or of the situation they are found in. It is not accounting even for these things to say that (for instance) the stone that is shown to us must have had *some* internal conformation or other. Nor does it mend the answer to add, with respect to the singularity of the conformation, that after the event it is no longer to be computed what the chances were against it. This is *always* to be computed when the question concerns whether a useful or imitative conformation is the product of chance. I desire no greater certainty in reasoning than that by which chance is excluded from the present disposition of the natural world. Universal experience is against it. What does chance ever do for us? In the human body, for instance, chance—i.e. the operation of causes without design—may produce a wen, a wart, a mole, a pimple, but never an eye. Among inanimate substances, a clod, a pebble, a liquid drop might be; but chance never created a watch, a telescope, an organised body of any kind, answering a valuable purpose by a complicated mechanism.

(4) Another answer, which has the same effect as resolving things into chance, says •that every animal and every plant, indeed every organised part thereof (such as the animal eye), are only some of the possible varieties of being that the lapse of infinite ages has brought into existence; and •that the present world is what is left of that variety, millions of other species having perished because their constitutions did not enable them to survive, or to propagate. Now, nothing we observe in the works of nature supports this conjecture; no such energy operates as that which is here supposed, which should be constantly pushing new varieties of beings into existence. Nor is there any evidence that every possible combination of vegetable or animal structure has formerly been tried. Multitudes of conformations of vegetables and animals may be conceived as capable of surviving and propagating that yet do not exist. We might have nations of human beings without nails on their fingers, with more or fewer fingers and toes than ten, some with one eye, others with one ear, with one nostril, or without the sense of smelling at all. No reason can be given why, if these lost species ever existed, they have now disappeared. But if all possible existences have been tried, they must have formed part of the catalogue.

Moreover, the division of organised substances into animals and vegetables, and the further distribution of each into genera and species—which is not an arbitrary act of the mind but based on the order that prevails in external nature—appears to me to contradict the supposition that the present world is the remains of an indefinite variety of existences, a variety that rejects all plan. The hypothesis says that every possible variety of being has somehow found its way into existence at some time, and that the badly formed ones perished; but it does not explain how or why the survivors should be cast into regular classes, as we see that plants and animals are; or rather the hypothesis is inconsistent with this phenomenon.

The hypothesis hardly deserves this much consideration. If someone told us that

> —because we had never seen watches, telescopes, stocking-mills, steam-engines, etc. made, did not know how they were made, and could not prove by testimony when or by whom they were made—

the curious [see Glossary] structures of these machines are to be explained thus:

> A mass of metals and other materials ran when melted into all possible shapes, and combined themselves in all possible forms and proportions; and the things that we see are merely the surviving stock of a magazine which, at one time or other, has contained every mechanism, useful, and useless, convenient and inconvenient, into which such like materials could be thrown,

what would we think of this? I cannot distinguish the hypothesis as applied to the works of nature from this solution as applied to a collection of machines, which no one would accept.

(5) To the marks of contrivance discoverable in animal bodies, and to the argument from these to the existence of a designing Creator, some have tried to give this turn:

> the parts were not intended for the use; the use arose out of the parts.

Well, a cabinet-maker rubs his mahogany with fish-skin, but no-one would say that the skin of the dog-fish was made rough and granulated so that cabinet-makers could use it for polishing wood; so the distinction is intelligible. But I think there is very little place for it in the works of nature. When roundly and generally affirmed of them, as it has sometimes been, it is analogous to this:

> *All* the implements of the cabinet-maker's workshop were substances accidentally configurated, which he had picked up and converted to his use; his adzes, saws, planes and gimlets were not made to work on wood with, but once they had been made—no matter with what purpose, if any—the cabinet-maker saw that they were applicable to his purpose, and turned them to account.

(a) And when this solution is applied to the parts of animals whose action does not depend on the will of the animal, it is even more evidently absurd. Is it possible to believe that the eye was formed without any regard to vision; that it was the animal itself which discovered that it would serve to see with, and that the use of the eye as an organ of sight resulted from the animal's application of this discovery? The same question may be asked of the ear, and of all the sense-organs. None of the senses fundamentally depend on the animal's choice or, therefore, on its sagacity or its experience. It is the impression objects make on the sense-organs that constitutes their use. In receiving that impression the animal is passive. It may bring objects within reach of the sense-organ; it may select these objects; but over the impression itself it has no power, or very little.

(b) There are many parts of animal bodies that seem to depend on the will of the animal in a greater degree than the senses do, and yet with respect to which this solution is equally unsatisfactory. Faced with a choice between these:

- **(i)** Teeth were made expressly for chewing food, feet for walking, hands for holding;
- **(ii)** Teeth etc. being as they are and being in fact in the animal's possession, its own ingenuity taught it that they were usable for these purposes, though no such purposes were contemplated in their formation;

no reasonable mind can hesitate in choosing **(i)**.

(c) The only thing that seems reasonable in this way of looking at things is this:

> In some cases the organisation seems to determine the habits of the animal, and its choice of a particular mode of life; and this could be called, in a certain sense, 'the use arising out of the part.'

However, in every such case we can say that the organisation determines the animal to habits beneficial and salutary to itself, and that this effect would not follow so regularly if the various organisations did not have a concerted and contrived relation to the substance by which the animal was surrounded. The web-foot determines the duck to swim, you say; but what use would that be if there were no water to swim in? The peculiar conformation of the bill, tongue and claws of the woodpecker determines that bird to search for his food among the insects lodged in the wood of decayed trees; but what would this profit it if there were no decayed trees with insects under their bark? The proboscis the bee is provided with determines him to seek for honey; but what would that signify if flowers supplied none? Faculties [see Glossary] thrown down on animals at random, without reference to the objects amidst which they are placed, would not provide them with the benefits that we see; and if there *is* that reference, there is intention.

(d) Lastly; the solution fails for plants, whose parts correspond to their uses with no input from the plant's will.

(6) Others have chosen to refer everything to a principle [see Glossary] of order in nature. That is their phrase, 'a principle of order'; but what this refers to other than an intelligent Creator has not been explained by definition or example; and without such explanation it seems to be a mere substitution of words for reasons, names for causes. *Order* is only the adaptation of means to an end; so a principle of it can only be the mind and intention that so adapts them. And if it can be explained in some other sense, is there any experience, any analogy, to sustain it? Was a watch ever produced by a principle of order? and why might not a watch be so produced as well as an eye?

Furthermore, a principle of order, acting blindly and without choice, is negated by the fact that order is not

- universal, which it would be if it issued from a constant and necessary principle, or
- indiscriminate, which it would be if it issued from an unthinking principle.

Where order is wanted, there we find it; where order is not wanted, i.e. where it would be useless if it did exist, there we do not find it. In the structure of the eye, in the shape and position of its various parts, the most exact order is maintained. In the forms of rocks and mountains, in shape of bays and promontories in the coasts of continents and islands, no order is perceived, because it would have been superfluous. No useful purpose would have arisen from moulding rocks and mountains into regular solids bounding the channel of the ocean by geometrical curves.

(7) Lastly, the confidence we place in our observations on the works of nature, in the marks we discover of contrivance, choice and design, and in our reasoning on the proofs provided us, ought not to be shaken—as some do try to shake it—by pointing to the general imperfection [see Glossary] of our knowledge of nature. In many cases this consideration ought not to affect us even when it respects some parts of the subject immediately under our notice. True strength of understanding consists in not allowing what we know to be disturbed by what we do not know. If we perceive a useful end, and means adapted to that end, we perceive enough for our conclusion; if these things are clear, no matter what is obscure, the argument is finished. If the usefulness of vision to the animal that has it, and the adaptation of the eye to this office [see Glossary] is evident and certain, ought the inference we draw from these premises to be prejudiced by the fact that we cannot explain the use of the spleen? Indeed, if there are parts of the eye manifestly suited to the forming of an image by the refraction of rays of light, the proof these provide of design and of a designer is not affected by there being *other* parts of the same eye whose agency or effect we can give no account of. Analogously, we would not and should not be inclined to doubt the purpose for which a telescope was constructed, or whether it was constructed at all, because it had certain screws and pins whose use or action we did not comprehend. I take this confidence-shaking move to be a general way of infusing doubts and scruples into the mind, to remind it of its own ignorance, its own incompetence; to tell us that on these subjects we know little, and that little imperfectly, or rather than we don't properly *know* anything about the matter. These suggestions sometimes produce a general distrust of our faculties and our conclusions, but this is unfounded. Before we yield in any particular instance to the scepticism that this sort of insinuation would induce, we ought to ascertain whether our ignorance or doubt concern the precise points on which our conclusion rests. Our ignorance of *other* points may be of no consequence to our argument, even if they are in various respects points of great importance. A sound reasoner removes from his consideration not only what he knows but also what he does *not* know regarding matters not strictly connected with his argument, i.e. not forming the very steps of his deduction.

6. The argument is cumulative

If the eye were the only example of contrivance in the world, that alone would be sufficient to support the conclusion I draw from it, regarding the necessity of an intelligent Creator. It could never be got rid of, because it could not be accounted for by any other supposition that did not contradict all our principles of knowledge. [Paley then re-states the relevant details concerning the eye, and says that they 'bear down all doubt' about the eye's having been designed.] And what I wish to observe in this chapter is that if other parts of nature were inaccessible to our inquiries—even if they presented to us nothing but disorder and confusion—the validity of this example would remain the same. If there were only one watch in the world, it would not be less certain that it had a maker. The proof is not a conclusion that lies at the end of a chain of reasoning, in which each instance of contrivance is only a link so that if one link fails the whole chain fails. Rather, a complete argument is separately supplied by every separate example. An error in stating an example affects only that example. The argument is *cumulative*, in the fullest sense of that term. The eye proves it without the ear; the ear without the eye. The proof in each example is complete; for when the design of the part, and the conduciveness of its structure to that design is shown, the mind may set itself at rest; no future consideration can detract anything from the force of the example.

7. The mechanical/non-mechanical distinction

In distinguishing the mechanical parts and processes of animals and vegetables from their non-mechanical parts and processes, I am not backing off from the thesis that

- every part of an animal or vegetable has proceeded from a contriving mind; that
- every part is constructed with a view to its proper end and purpose; and that
- every part is so constructed as to achieve its purpose while operating according to the relevant laws.

The point of the distinction is rather this: these laws themselves are not in all cases equally understood, or—what amounts to nearly the same thing—are not equally exemplified in simpler processes and simpler machines; ·and it is only when they *are* thus understood and exemplified that we call the processes they govern 'mechanical'·.

For instance: the principle [see Glossary] that drives muscular contractions, whether by an act of the will or by involuntary irritation, is wholly unknown to us. We know nothing of the substance employed or of the laws that regulate its action. We see nothing similar to this contraction in any machine we can make or any process we can execute. So far (it is confessed) we are in ignorance, but no further; ·and we label this principle '**non-mechanical**'·. Given this power and principle, the collocation of the fibres to receive the principle—the disposition of the muscles for the use and application of the power—is **mechanical**, and is as intelligible as the wires and strings by which a puppet is moved.

The nervous influence by which the middle of the muscle is swelled is not mechanical. We see the usefulness of the effect, but not the preparation of the means by which it is produced. But obscurity regarding the origin of muscular motion brings no doubtfulness into our observations regarding the motion itself:

- **(a)** the constitution of the muscle, such that the swelling of the middle part is necessarily and mechanically followed by a contraction of the tendons;
- **(b)** the astonishingly great number and variety of the muscles and the corresponding number and variety of useful powers they provide the animal with;
- **(c)** the wise and well-contrived disposition of each muscle for its specific purpose.

[He goes into details regarding **(c)**.] All this is mechanical, and is as accessible to inspection, as capable of being ascertained, as the mechanism of the automaton in the Strand.

That *an animal is a machine* is a proposition neither correctly [perhaps he meant to write 'completely'] true nor wholly false. The distinction I have been discussing shows how far the animal-machine comparison holds, and where it fails. Granted that we know nothing of voluntary motion, of irritability, of the principle of life, of sensation, of animal heat, this ignorance does not compromise our knowledge of the mechanical parts of the animal frame. There *is* mechanism in animals; this mechanism is as properly such as it is in machines made by art; it is intelligible and certain, and is not less so because it often begins or terminates with something that is not mechanical; wherever it is intelligible and certain, it demonstrates intention and contrivance in the works of nature as well as in those of art; and that it is the best demonstration that either can provide.

But there are other cases where, although we cannot exhibit mechanism or even prove that mechanism is employed, we have sufficient evidence of intention and contrivance.

There is what may be called the *chemical* part of our frame. Because of the imperfection of our chemistry, we cannot attain a knowledge of this that is similar in degree or in kind to our knowledge of the mechanical part of our frame. So it does not provide the same species of argument as that mechanism supplies; yet it may provide an argument that is highly satisfactory. The gastric juice that digests the food in the stomachs of animals is of this class. [He talks about the power, versatility and selectiveness of the digestive system, and concludes:] Consider these properties of the digestive organ and of the juice with which it is made to supply itself, and you will confess that it has rightly been called 'the chemical wonder of animal nature'.

Yet we are ignorant of the composition of this fluid and of the mode of its action; by which I mean that we cannot set it alongside the operations of ·human· art, as we can the mechanical part of our frame. I call this the imperfection of our chemistry. The time may come when we can assemble ingredients so as to make a solvent that acts in the way the gastric juice acts; and that may enable us to ascertain the chemical principles on which its efficacy depends, as well as from what part and by what concoction in the human body these principles are generated and derived.

In the meantime, ought the defect of our chemistry hinder us from accepting the inference that a production of nature authorises us—by its place, its properties, its action, its surprising efficacy, its invaluable use—to draw regarding a creative design?

Another most subtle and curious function of animal bodies is secretion. This function is semi-chemical and semi-mechanical, exceedingly important and diversified in its effects but obscure in its process and in its apparatus. The importance of the secretory organs is all too well attested by the diseases that are almost sure to arise from a secretion that is excessive, or deficient, or wrong: a single wrong secretion is enough to make life miserable, and sometimes to destroy it. And the variety matches the importance: from one and the same human blood about twenty different fluids are separated, with utterly different sensible properties; and if we pass to other species of animals, we find among their secretions not only the most various but the most opposite properties—nutritious food and deadly poison, sweet perfumes and foul odours. Most of these, after they are secreted, evidently contribute to the welfare of the animal. (Similar to secretion, if not the same thing, is *assimilation*, by which blood is converted into bone, muscular flesh, nerves, membranes, tendons—things as different as the wood and iron, canvas and cordage, of a ship.)

No operation of art is exactly comparable with all this, perhaps only because all the operations of art are *exceeded* by it. We are not acquainted with any chemical election, any chemical analysis or resolution of a substance into its constituent parts, any mechanical sifting or division, that rises to the level of animal secretion in perfection or variety. Yet the apparatus and process are obscure, not to say absolutely concealed from our inquiries.

In estimating the evidence animal secretions provide of design, think about their variety and their appropriateness to their place and use. They all come from the same blood; they are all drawn off by glands; yet the product is very different, and the difference exactly adapted to the work that is to be done. No account can be given of this without resorting to *appointment*. Why is the saliva insipid, when so many other secretions—urine, tears, and sweat—are salt? Why does the gland within the ear separate a waxy substance that defends that passage, while the gland in the upper angle of the eye secretes a thin brine that washes the eyeball? These are fair questions; and the only answer they can be given brings in intelligence and intention.

My aim in the present chapter has been to teach three things: **(i)** that it is a mistake to suppose that, in reasoning from the appearances of nature, the imperfection [see Glossary] of our knowledge proportionally affects the certainty of our conclusion, for in many cases it does not affect it at all; **(ii)** that the different parts of the animal frame can be classed and distributed according to how exactly we can compare them with works of art; **(iii)** that the mechanical parts of our frame—i.e. those in which this comparison is most complete—although they are probably the coarsest portions of nature's workmanship, are the most proper to be adduced as proofs and examples of design.

8. Mechanisms: bones

I shall discuss certain examples from this class, choosing ones that can be explained without plates, shapes, or technical language, and of those the ones that appear to be the most striking and the best understood.

Bones in general

(1) I challenge any man to produce, in the joints and pivots of the most complicated or most flexible machine ever contrived, a construction more artificial [see Glossary] or more evidently artificial than what is seen in the vertebrae of the human neck. The head was to have the power of **a** bending forward and backward, and of **b** rotating through about 120° of a circle. For these purposes two contrivances are employed. **a** First, the head rests immediately on the uppermost vertebra, and is united to it by a hinge-joint, on which the head plays freely forward and backward. **b** Secondly, between the uppermost vertebra in the neck and the one next below it there is a mechanism resembling a tenon and mortice. The lower of the two has a projection, something like a tooth, which fits into a corresponding socket in the bone above it, forming a pivot on which that upper bone, together with the head it supports, turns freely in a circle. Thus are both motions perfect, without interfering with each other. We see the same contrivance in the mounting of a telescope, for moving it up and down as well as horizontally: **a** a hinge on which the telescope plays, and **b** an axis on which the telescope and the hinge turn around together.

(2) Similar to that in its object, though different in its means, is the mechanism of the forearm. For this, two motions are wanted: **a** a motion at the elbow backward and forward, and **b** a rotatory motion by which the palm of the hand may be turned upward. How is this managed? The forearm consists of two bones lying alongside each other but touching only towards the ends. **a** One of these bones is joined to the upper part of the arm at the elbow; **b** the other is joined to the hand at the wrist. The first, by means of a hinge joint at the elbow, swings backward and forward, carrying with it the whole forearm. The other bone, to which the hand is attached, rolls on the first bone by the help of a groove or hollow near each end of one bone, to which is fitted a corresponding prominence in the other. If both bones had been joined to the upper arm at the elbow, or both to the hand at the wrist, the thing could not have been done. The first was to be at liberty at one end, and the second at the other, so that the two actions could be performed together. [Paley elaborates this account at considerable length.]

(3) The spine is a chain of joints of very wonderful construction; various difficult and almost inconsistent offices were to be performed by the same instrument. It was to be **a** firm, to support the erect position of the body, and **b** flexible, to allow the trunk to bend in all degrees of curvature. It was further also **c** to become a pipe or conduit for the safe conveyance from the brain of the spinal marrow—

> the most important fluid of the animal frame, on which all voluntary motion depends, a substance needed for action, if not for life, but also so delicate and tender that any unusual pressure on it or obstruction of its course is followed by paralysis or death.

As well as providing the main trunk for the passage of the medullary substance from the brain, the spine had to **d** give out along the way small pipes which being afterwards indefinitely subdivided could (under the name of 'nerves') distribute this exquisite supply to every part of the body. The same spine was also to **e** provide a fulcrum (or more properly speaking a series of these) for the insertion of the muscles that are spread over the trunk of the body.

Commission a workman to make a mechanism that will achieve all these purposes, and he will find it hard to comply until he is told how the same thing is effected in the animal frame.

For the spine to be **a** firm yet **b** flexible, it is composed of a great number of bones (in humans twenty-four) joined to one another and compacted by broad bases. The breadth of the bases on which the parts separately rest and the closeness of the junction give the chain its firmness and stability; the number of parts, and consequent frequency of joints, provide its flexibility. In order to provide **c** a passage for the descent of the medullary substance, each bone is bored through in such a way that the hole in any one bone lines up with the holes in the two bones contiguous to it; so that the perforated pieces form an entire, close, uninterrupted channel; at least while the spine is upright and at rest. But there had also to be some way to prevent the vertebrae from shifting on one another, so as to break the line of the canal when the body moves or twists; and to prevent the joints from gaping externally when the body is bent forward. [Paley describes the 'mechanical' solution to this problem, involving the interlocking of the vertebrae and the placing of 'springy' cartilages between them.] **d** For the medullary canal to send out a supply of nerves to different parts of the body, notches are made in the upper and lower edge of every vertebra, two on each edge, equidistant on each side from the middle line of the back. These notches, exactly fitting, form small holes through which the nerves issue out in pairs, to send their branches to every part of the body. As for **e** the insertion of the bases of the muscles, a shape specifically suited to this design and unnecessary for the other purposes is given to the constituent bones.

[Paley then describes how the vertebrae 'lock in with and overwrap one another' so as to prevent any 'from being pushed out of its place', and notes that we can see, understand, and admire this arrangement in the spine of a hare after its meat has been eaten. He concludes:] The general result is that •the motions of the human body needed for everyday life are performed with safety, and that •it seldom happens that an acrobat's movements distort his spine.

The structure of the spine is not in general different in different animals. In the serpent tribe it *is* considerably varied, but with a strict reference to the convenience of the animal. Whereas quadrupeds have 30 to 40 vertebrae, serpents have nearly 150; whereas in men and quadrupeds the surfaces of the bones are flat, and these flat surfaces laid one against the other and tightly bound by sinews, in serpents the bones play one within another like a ball and socket, so that they have a free motion on one another in every direction. In short, in men and quadrupeds firmness is more consulted; in serpents, pliancy.

(4) The reciprocal enlargement and contraction of the chest to allow for the play of the lungs depends on a simple yet beautiful mechanical contrivance involving the structure of the bones that enclose it. The ribs articulated to the back-bone, in their natural position, slope from the place of articulation downwards. The result is that **a** when they come to move, whatever pulls the ribs upwards necessarily also draws them out; and that **b** while the ribs are brought to a right angle with the spine behind, the sternum—the part of the chest they are attached to in front—is thrust forward. So the simple action of the elevating muscles does the business. If **a** the ribs had been articulated with the vertebrae at right angles, the cavity of the thorax could never have been further enlarged by a change of their position; and if **b** each rib had been a rigid bone rigidly fixed at both ends, the whole chest would have been immovable. The thorax, says Schelhammer, forms a kind of bellows such as never has been and probably never will be made by any artificer.

(5) The patella or kneecap is a curious little bone, different in form and office from any other bone in the body. [He describes its shape and situation, and its 'offices', mainly protecting the knee-joint from injury. He adds:] It appears to be supplemental to the frame, not quite necessary but very convenient. [He then writes about the shoulder-blade, commenting on its singular lack of connection with any other bones (‘in strictness, it forms no part of the skeleton’), but not offering it as evidence of contrivance.]

Joints

(1) The above are a few examples of bones made remarkable by their configuration; but almost all the bones have joints, in which we see both contrivance and contriving wisdom even more clearly than in the shape of the bones themselves. There are two sorts of joint: **a** the hinge and **b** the ball and socket; and one or the other prevails, depending on what motion is wanted. For example, the **b** ball and socket joint is not required at the knee, because the leg needs only a motion backward and forward in the same plane, for which **a** a hinge joint is sufficient. A **b** ball and socket joint is needed at the hip, to provide not only for walking forwards but also for spreading the legs. Think what would have been the inconvenience if the ball and socket joint had been at the knee, and the hinge joint at the hip! The disadvantage would not have been less if the joints at the hip and the knee had both been of the ball and socket type, or both been hinges: yet why, apart from utility and a Creator who consulted that utility, should the thigh bone be **b** rounded at one end and **a** channelled at the other?

The hinge joint is not formed by a bolt passing through the two parts of the hinge and thus keeping them in their places; but by a different expedient. A tough, parchment-like membrane, arising from the receiving bones and inserted all around the received bones a little below their heads, encloses the joint on every side. This membrane holds the ends of the bones together, keeping the corresponding convexities and concavities in close application to each other.

The ball and socket joint also has a membrane like that; and for some important joints there is an additional security—a short, strong, flexible ligament inserted by one end into the head of the ball, by the other into the bottom of the cup. This keeps the two parts of the joint so firmly in their place that none of the motions the limb naturally performs can pull them apart. This ligament, which is so flexible that it does not hinder the suppleness of the joint, is too strong to be ruptured and too well protected by bone to be cut. I don’t know if there is any example of mechanism more unambiguous, or more free from objection, than this ligament. It is utterly mechanical, subservient to the safety of the joint, yet incapable of being *generated* by the joint’s action. I would especially ask you to attend to this provision, as it is found in the head of the thigh-bone—to its strength, its structure, and its use. It is an instance on which I lay my hand. For various reasons we multiply examples; but for the purpose of strict argument one clear instance is sufficient; and not only sufficient but capable perhaps of generating a firmer assurance than can arise from a divided attention.

Another no less important hinge joint is the ankle. This joint is strengthened by two remarkable prolongations of the bones of the leg, forming the protuberances that we call the inner and outer ankle. Between both the ankle is locked in its position. I know no explanation for this structure except its utility. Why should the tibia’s lower end be double, with one part going lower than the other, and similarly for the fibula’s, except to protect the joint on both sides?

The joint at the shoulder compared with the joint at the hip, though both are ball and socket joints, shows a difference in their form and proportions that is well suited to the relevant limbs’ different offices. The socket at the shoulder is much shallower and flatter than the one at the hip, and unlike the other is partly made of cartilage set around the rim. This fits with the duties assigned to each part: the arm is principally an instrument of motion; whereas the lower limb has to support the body as well as being the means of its locomotion, so for it firmness was to be consulted as well as action.

We every moment experience the suppleness and pliability of the joints. As for the firmness of animal articulation, consider the fact that despite the contortions and wrenches to which the limbs of animals are continually subject, there are millions of animal joints in complete repair and use for every one that is dislocated.

(2) The nerves, blood-vessels and tendons that are necessary for the animal's life or for the motion of the limbs must travel over the movable joints, and must be protected from compression, attrition, or laceration through sudden motions and abrupt changes of curvature. This is done with peculiar care by a provision in the shape of the bones themselves. [He describes how this is done at the elbow, at the knee, and at the shoulder, with a colourful summing up of the knee situation:] The great vessels and nerves that go to the leg pass along a defile between rocks.

(3) The ends of the bones that work against each other in a joint are tipped with gristle; in the ball and socket joint the cup is lined and the ball capped with it. The smooth surface and the elastic and unfriable nature of cartilage make it the most proper of all substances for the place and purpose. I would have pointed this out earlier, if it had not been alleged that cartilage is really only imperfect bone, kept soft and imperfect by the continual motion and rubbing of the surfaces; in which case it is not **a designed advantage** but merely **an unavoidable effect**. I am not convinced that this is correct: the surmounting of the ends of the bones with gristle looks to me more like •a plating with a different metal than like •the same metal kept in a different state by the action to which it is exposed. Either way, we have a great *particular* benefit; if it arises from a *general* constitution, it is not quite what my argument requires; and I have thought it fair to state the question that arises about it, lest I should seem to overrate its value.

(4) [A discussion of the 'loose cartilages' in some joints, especially the knee, whose 'slipping and sliding' facilitates the working of the joint. Paley compares them with the 'loose rings' that mechanics put 'between the parts of crook-hinges of large gates'.]

(5) We have now done with the configuration of the joints; but there is also in them all a regular supply of a mucilage, more emollient and slippery than oil itself, which constantly softens and lubricates the parts that rub on each other and thereby enormously reduces the amount of wear. For the continual secretion of this important liniment, and for feeding the cavities of the joint with it, glands are fixed near to each joint. A recent improvement in so-called 'friction wheels'—a mechanism in which oil is regularly dropped into a box that encloses the axis, the nave, and ball-bearings on which the nave revolves—has some resemblance to the contrivance in the animal joint; but the joint is superior, because in it the oil is not only dropped but made.

In considering the joints, there is perhaps nothing that should move our gratitude more than *how well they wear*. A limb swings on its hinge or plays in its socket hundreds of times an hour, for sixty years, without losing any of its agility. I attribute this durability in part to •the provision that is made for preventing wear and tear by the polish of the cartilaginous surfaces and by the healing lubrication of the mucilage; and in part to •that astonishing property of animal constitutions, *assimilation*, by which throughout the body substance is restored and waste repaired.

The union of bones, even where no motion is intended or wanted, carries marks of mechanism and of mechanical wisdom. The teeth, especially the front teeth, are one bone fixed in another like a peg driven into a board. The sutures of the skull are like the edges of two saws pushed together so that the teeth of one enter the intervals of the other. We have sometimes one bone lapping over another and planed down at the edges; sometimes the thin lamella of one bone received into a narrow furrow of another. All these seem to reveal the same design, namely firmness of union without clumsiness in the seam.

9. Mechanisms: muscles

Muscles, with their tendons, are the instruments by which animal motion is performed. I shall point out instances in which, and properties with respect to which, the disposition of these muscles is as strictly mechanical as that of the wires and strings of a puppet.

(1) Throughout the animal body there is an exact relation between the joint and the muscles that move it; whatever motion the joint's mechanical construction enables it to perform can be produced by the annexed muscles by virtue of their position. For example, when (as at the knee and elbow) there is a hinge joint, capable of motion only in the same plane, the muscular tendons are parallel to the bone, so that by the contraction or relaxation of the muscles they produce that motion and no other. If these joints were capable of a freer motion, there are no muscles to produce it. Whereas at the shoulder and the hip, where the ball and socket joint allows of a rotatory or sweeping motion, tendons are so placed as to produce the motion of which the joint admits. [He goes into some detail about the hip, then moves on to the head and hands, noting a special feature of the muscles relating to the head, namely that they are] capable of steadying the globe as well as of moving it. The head of a new-born infant is often obliged to be held up; after death, the head drops and rolls in every direction.

As another example of the conformity of use between the bones and the muscles, it has been observed that the processes of the different vertebrae are exactly proportioned to the amount of motion that the other bones allow of and that the relevant muscles are capable of producing.

(2) A muscle acts only by contraction; its force is exerted in no other way. When the exertion ceases, the muscle returns by relaxation to its former state, but without energy. This is the nature of the muscular fibre. Because of this, a limb can be moved with force in opposite directions only if it has opposite or antagonist muscles, flexors and extensors corresponding to each other. [He describes these in some detail for the elbow, then continues:] The same thing obtains for every movable part of the body. Every muscle is provided with an adversary. They act, like two sawyers in a pit, by an opposite pull; and nothing can more strongly indicate design and purpose than their being thus placed in this way.

(3) Another property of the muscles that could only be the result of care is their being almost universally so disposed as not to interfere with one another's action. (The only example of such interference that I know of is the fact that we cannot easily swallow while we gape.) There are at least 446 muscles in the human body, known and named, situated in layers over one another, crossing one another, sometimes embedded in one another, sometimes perforating one another; yet each has its liberty, its full play; and this can only have come from meditation and forethought.

(4) It is often the case that a muscle's action is needed at a place where it would be inconvenient for the muscle to be situated. In such a case the body of the muscle is placed at a distance and made to communicate with the point of action by slender strings or wires. If the muscles that move the fingers had been placed in the palm or back of the hand, they would have swelled that part to an awkward and clumsy thickness. So they are disposed in the arm, even up to the elbow, and act by long tendons, strapped down at the wrist and passing under the ligaments to the joints of the fingers that they are severally to move. Similarly with the muscles that move the toes, and the muscle that draws the eyelid over the eye.

(5) It appears to be a fixed law that *the contraction of a muscle shall be towards its centre*. So each muscle has to have a shape and position that will produce the required motion, in conformity with this law. So we find muscles with a multiplicity of forms and attitudes; sometimes with double tendons, sometimes with treble, sometimes with none; sometimes one tendon to several muscles, at other times one muscle to several tendons. The shape of the organ is capable of enormous variety, while the unchanging law and line of its contraction is simple. The muscular system is in this respect like our works of art [see Glossary]. An artist does not alter the basic nature of his materials, or their laws of action. He takes these as he finds them. His skill and ingenuity are employed in turning them to his account, by giving to the parts of his machine a form and relation in which these properties can produce the intended effects.

(6) We can never say it too often:

- •How many things must go right for us to be at ease for an hour!
- •How many more things must go right for us to be vigorous and active!

Yet vigour and activity are preserved in nearly all human bodies, although they depend on so many instruments of motion, and although the defect of a single pair out of the 446 muscles that are employed may bring grievous inconvenience. [He tells of a man who, because of the failure of 'two little muscles', could raise his eyelids only by hand.] Those who enjoy the perfect use of their organs are in general very unaware of the comprehensiveness of the blessing, the variety of their obligation. They perceive a result, but hardly think of the multitude of concurrences and rectitudes that produce it.

The speed and precision of muscular motion

(1) The variety, quickness and precision that muscular motion is capable of are nowhere more remarkable than in the tongue. Watch the agility of your tongue—the wonderful speed and exactness with which it changes its position. Each syllable of articulated sound requires a specific action of the tongue and of the parts adjacent to it. Every letter and word requires a disposition and configuration of the mouth that is not only special to that sound but, if carefully attended to, perceptible to the sight; a fact that has enabled some people to teach the deaf to speak and to understand what is said by others. After someone's habit of speaking has been formed, one and only one position of the parts will yield a given articulate sound correctly. How instantaneously are these positions adopted and then dismissed! How numerous are the permutations, how various yet how infallible! I believe that the •anatomy of the tongue corresponds with these observations on its •activity. Its muscles are so numerous and so interwoven that they cannot be traced by the most careful dissection; yet neither the number, nor the complexity, nor the apparent entanglement of its fibres in any way impede its motion or make the success of its efforts uncertain. This is a great perfection of the organ.

A digression on the mouth

Allow me to step a little out of my way to consider some of other properties of the parts of the mouth. An eminent physiologist has said that whenever nature tries to work two or more purposes by one instrument, it does them imperfectly. Is this true of the tongue, regarded as an instrument of speech, of taste, and of swallowing? It is so far from true that 99.9% of persons, by the instrumentality of this one organ, talk, taste and swallow very well. In fact, the constant warmth and moisture of the tongue, the thinness of the skin and the papillae on its surface qualify this organ for its office of tasting, as much as its inextricable multiplicity of fibres qualify it for the rapid movements needed for speech.

The cavity of the mouth involves more distinct uses, and contains parts performing more distinct offices, than I think can be found lying so near to one another in any other part of the body, namely:

- teeth of different shapes, first for cutting, secondly for grinding;
- muscles artfully disposed for carrying on the compound motion of the lower jaw, half lateral and half vertical, by which the mill is worked;
- fountains of saliva, springing up in different parts of the mouth for moistening the food while it is being chewed;
- glands to feed the fountains;
- a very special kind of muscular constriction at the back of the cavity, for guiding the prepared food into its passage towards the stomach and in many cases for carrying it along that passage.

We may imagine this last to be done simply by the weight of the food itself, but in truth it is not so.

In the meantime, within the same cavity, another business is going on—that of breathing and speech. In addition to the apparatus described above, we have

- a passage from this cavity to the lungs, to admit air and nothing else;
- muscles, some in the larynx and countless others in the tongue, to modulate that air in its passage with more variety, range and precision than any other musical instrument is capable of;

and, the crowning achievement,

- a specific contrivance for dividing the pneumatic part from the mechanical—the breathing from the eating—and preventing one set of actions interfering with the other.

Where various functions are united, the problem is to guard against the drawbacks of too much complexity. I know of no humanly constructed apparatus where such multifarious uses are so aptly combined, or where the structure (compared with the uses) is so simple, as in the human mouth. The mouth is one machine, with its parts neither crowded nor confused, and each unembarrassed by the rest; each at least sufficiently at liberty for the end to be attained. If we cannot eat while we sing, we can eat at one moment and sing the next, with breathing proceeding freely all the while.

However, the mouth alone could not perform the double office of sucking and breathing. So another route is opened for the air, namely through the nose, which lets the breath pass backward and forward while the lips have to be shut close on the body from which the nutriment is drawn. The nose would have been necessary even if it were not the organ of smelling. Making it the seat of a *sense* was wisely adding a new use to a part that was already needed.

Returning to the speed and precision of muscles

But to return to the proper subject of the present section, the speed and precision of muscular motion.

(1) These qualities are very visible in the performance of many kinds of instrumental music, where the movements of the musician's hand are exceedingly rapid and are exactly measured even when they are very minute. They display, on the part of the muscles, an obedience of action that is wonderful for its speed and its correctness.

Or observe your own hand while you are writing: the number of muscles that are brought to bear on the pen; how the operation of several tendons is involved in every stroke, yet five hundred such strokes are drawn in a minute. When we look at he finished product, how faithful the muscles have been to their duty! how true to the order inculcated by endeavour or habit! Bear in mind that while a man's handwriting is the same, an exactitude of order is preserved, whether he writes well or badly. The examples of music and writing show not only the speed and precision of muscular action, but also its docility [i.e. its capacity to be trained].

(2) Sphincter or circular muscles appear to me admirable pieces of mechanism, because their semi-voluntary character is exactly what suits the wants and functions of the animal. [He explains, not very clearly, what this character consists in: much of the time we can choose whether to keep a sphincter closed or let it open, but when the pressure is great enough we cannot keep it closed.]

(3) Many of our most important actions are achieved by the combined help of different muscles. Sometimes the number of co-operating muscles is very great. Dr Nieuentyt in the *Leipsic Transactions* reckons that a hundred muscles are employed every time we breathe; yet we breathe in and out without reflecting on what a work is thereby performed—how many instruments contribute to this. Breathing with ease is a blessing of every moment, yet it is the one we are least conscious of. A man with asthma is the only one who knows how to estimate it.

(4) Mr Home has observed that the most important and the most delicate actions are performed in the body by the smallest muscles. The examples he gives are the muscles that have been discovered in the iris of the eye and in the drum of the ear. The thinness of these muscles is astonishing. They are microscopic hairs, and must be magnified to be visible; yet are they real, effective muscles whose health and action are required for the grandest and most precious of our faculties, sight and hearing.

(5) The muscles act in the limbs with what is called a "mechanical disadvantage'. [Paley explains this as what you have in raising •a light weight a good distance along a lever by means of •a heavy weight very close to the fulcrum.] The muscle at the shoulder is of this kind. It would indeed be a disadvantage if the aim were to spare the force of muscular contraction [i.e. to avoid the analogue of the heavy weight]. But that is usually not what is wanted. Mechanism always aims either at **a** moving a great weight slowly through a small space or **b** moving a light weight rapidly through a considerable sweep. For **a** the former of these a different arrangement of the muscles might be better than the actual one, but for **b** the second purpose the actual structure is just right. Now it so happens that **b** the second and not the **a** first is what the occasions of animal life principally call for. On some extraordinary occasions a man may wish he could **a** raise from the ground a much heavier load than he can lift at present; but it is much more important for him to be able to **b** raise his hand to his head quickly, this being something he wants and uses every hour or minute. In general, the vivacity of animals' motions would be ill exchanged for greater force under a clumsier structure.

I have discussed muscles in general, then certain species of muscles; but there are also single muscles that bear marks of mechanical contrivance. Out of many instances of this kind I select the following.

Three individual muscles

(1) [In this paragraph Paley describes in some detail the muscular structure that produces, 'in a most wonderful and elegant manner', the movement of the lower jaw.]

(2) What contrivance can be more mechanical than a slit in one tendon to let another tendon pass through it? This structure is found in the tendons that move the toes and fingers. The long tendon in the foot, which bends the first joint of the toe, passes through the short tendon which bends the second joint; and this course allows to the sinew more liberty and a more free action than it could have exerted otherwise. I don't think that in a silk or cotton mill—in the belts, straps, ropes by which motion is communicated from one part of the machine to another—there is anything more artificial, or more evidently so, than this perforation.

(3) The tendons that pass from the leg to the foot are bound down by a ligament at the ankle. The foot is placed at a considerable angle with the leg. Obviously, flexible strings passing along the interior of the angle would, if left to themselves, pull away from it. The obvious preventive is to tie them down, and that is what is done in fact. Just above the instep the anatomist finds a strong ligament *under* which the tendons pass to the foot. The effect of the ligament as a bandage can be made evident to the senses; for if it is cut, the tendons move upwards. The simplicity yet clearness of this contrivance—its exact resemblance to established resources of ·human· art—make it one of the most convincing signs of *design* that we know.

The present example precisely contradicts the opinion that the parts of animals may have all been formed by *endeavour*, perpetuated and imperceptibly working its effect through an incalculable series of generations. We have here no endeavour but the reverse of it—a constant resistance and reluctance, the endeavour all going the other way. The pressure of the ligament constrains the tendons; the tendons react to the pressure of the ligament. The ligament could not possibly have been generated by the exercise of the tendon, because the force of the tendon perpendicularly resists the fibre that confines it and is constantly endeavouring not to •form the threads of which the ligament is composed but to •rupture and displace them.

Two final remarks about muscles

Bishop Wilkins has observed from Galen that there are at least ten factors to be attended to in each muscle:

- •its proper shape,
- •its just magnitude,
- •its fulcrum,
- •its point of action, supposing the shape to be fixed,
- •its collocation with respect to its upper and lower ends,
- •the place,
- •the position of the whole muscle,
- •the introduction into it of nerves,
- •arteries,
- •veins.

How can things needing so many adjustments be made, and when they are made how can they be put together, without intelligence?

I have sometimes wondered why we are not struck with mechanism in animal bodies as readily and as strongly as we are struck with it at first sight in a watch or a mill. Perhaps it is partly because animal bodies are largely composed of soft, flabby substances such as muscles and membranes; whereas we have been accustomed to detecting mechanism in sharp lines, in the configuration of hard materials, in the moulding, chiselling, and filing into shapes of materials such as metals or wood. In fact, mechanism can be displayed in the soft kind of substance as well as in the hard; it is sufficiently evident that there can be no proper reason for any distinction of the sort.

10. Mechanisms: vessels

(1) The circulation of the blood through the bodies of men and quadrupeds, and the apparatus by which it is carried on, compose a system that is perhaps the best understood part of the animal frame. The lymphatic system and the nervous system may be more subtle and intricate; indeed, in their structure they *may* be even more artificial than the blood system; but we do not know so much about them.

One grand purpose of the circulation of the blood is the distribution of the nourishment that the body receives by one aperture to every part, every extremity, every nook and corner, of it. What enters at the mouth finds its way to the fingers' ends. How to repair the waste of a complicated machine while also giving some substance access to every part of it—a difficult mechanical problem!

This system involves two factors: •the disposition of the blood-vessels, i.e. the laying of the pipes; and •the construction of the engine at the centre—namely, the heart—for driving the blood through them.

The lay-out of the pipes

The disposition of the blood-vessels for supplying blood to the body is like that of the water-pipes in a city—large trunks branching off into smaller pipes (and these again by still narrower tubes) in every direction, towards every part where the conveyed fluid can be wanted. But another thing that is necessary for the blood but not wanted for the water is carrying it back again to its source. For this office a reversed system of vessels is prepared. These unite at their extremities with the extremities of the vessels of first system; they collect the divided and subdivided streamlets, first by capillary ramifications into larger branches and then by these branches into trunks; and in this way the second system returns the blood (almost exactly inverting the order in which it went out) to the fountain from which its motion proceeded. All this is evident mechanism.

So the body contains two systems of blood-vessels, arteries and veins, between which there are two differences, suited to the functions the systems have to perform. **a** Because the blood in going out passes from wider into narrower tubes, and in coming back from narrower into wider, it is evident that the pressure on the sides of the blood-vessel will be much greater in one case than the other. Accordingly, the arteries that carry out the blood are formed of much tougher coats than the veins that bring it back. **b** Because of the greater force with which the blood is urged along the arteries, a wound or rupture in them would be more dangerous than one in the veins; so these vessels are defended from injury not only by their texture but by every advantage of *situation* that can be given to them. They are buried in sinuses, or they creep along grooves made for them in the bones. Sometimes they proceed in channels, protected by stout parapets on each side, notably in the bones of the fingers. At other times the arteries pass in canals wrought in the very middle of the substance of the bone—for example in the lower jaw, where there would otherwise be danger of compression by sudden curvature. All this care is wonderful, yet not more than what the importance of the case required. It has been often said that for those who venture their lives in a ship there is only an inch-board between them and death; but in the body itself, especially in **a** the arterial system, there is in many parts only a membrane, a skin, a thread. That is why this system lies deep under the integuments, whereas **b** the veins, in which the harm from injury is much less, generally lie above the arteries, come nearer to the surface, are more exposed.

The arterial system, with its trunk and branches and small twigs, may be imagined to *grow* from the heart, like a plant from its root; but the returning system of veins could not be formed in this manner. The arteries might go on shooting out from their extremities, lengthening and •dividing indefinitely; but an inverted system, continually •uniting its streams, could not arise from the same process.

The engine at the centre

The next thing to be considered is the engine that works this machinery, namely the heart. For my purpose it is unnecessary to know what drives the heart; all that matters is that it is *something* that can produce alternating contraction and relaxation in a living muscular fibre. This is the power we have to work with, and the inquiry concerns how this power is applied in the instance before us. In the central part of the body there is a hollow muscle, invested with spiral fibres running in both directions, the layers intersecting one another. By the contraction of these fibres the sides of the muscular cavities are squeezed together so as to force out from them any fluid they contain; by the relaxation of the same fibres the cavities are dilated and thus prepared to admit every fluid that may be poured into them. Into these cavities are inserted the great trunks, both of the arteries that carry out the blood and of the veins that bring it back. That is, by each contraction a portion of blood is forced by a syringe into the arteries: and at each dilatation an equal portion is received from the veins. [He exclaims about the sheer amount of blood that passes through the human heart in an hour, with the account rising to a crescendo in describing what happens in the heart of a whale.]

The foregoing account is true but imperfect [see Glossary]. The heart also performs another office, which is of equal curiosity and importance. It was necessary that the blood should be successively brought into contact, or contiguity, or proximity with the air. [He says that it isn't certain *why* there is this need, though probably blood has a role in the transfer of impurities between the 'pure and vital' air we breathe in and the 'foul and noxious' air we breathe out. Uncertainty about why the blood needs to be 'visited by continual accesses of air' does not matter here, because] it is sufficient to know that in the constitution of most animals air must be introduced somehow into a near communication with the blood. The lungs of animals are constructed for this purpose. They consist of blood-vessels and air-vessels lying close to each other; with each branch of the windpipe lying between a branch of the vein and a branch of the artery. When the blood is received by the heart from the veins of the body, and *before* it is sent out again into its arteries, it is forced by the contraction of the heart along a supplementary artery to the lungs. Then, after it has been concocted and prepared by the action (whatever it may be) of the lungs, it is brought back to the heart by a large vein and from there is distributed anew into the system. This gives the heart a double office. The pulmonary circulation is a system within a system, and one action of the heart is the origin of both.

Four cavities are needed for this complicated function, and four are accordingly provided:

- •two 'ventricles', one sending blood into the lungs, the other sending it into the rest of the body after it has returned from the lungs; and
- •two 'auricles', one receiving blood immediately from the body, the other receiving it after its circulation through the lungs.

So there are two forcing cavities and two receiving cavities. The receiving cavities communicate with the forcing cavities and, by their contraction, unload the received blood into them; and the forcing cavities by *their* contraction compel the same blood into the mouths of the arteries.

'The wisdom of the Creator', says Hamburgher, 'is in nothing seen more gloriously than in the heart.' And how well it does its job! An anatomist who understood the structure of the heart might predict that it would work; but I think he would expect, given the complexity of its mechanism and the delicacy of many of its parts, that it would always be liable to breakdown, or that it would soon wear out. Yet this wonderful machine keeps going, night and day, for 80 years together at the rate of 100,000 strokes every twenty-four hours, having at every stroke to overcome a great resistance—doing this without disorder and without weariness!

A valve is placed in the communication between each auricle and its ventricle, so that when the ventricle contracts, none of the blood goes back into the auricle instead of entering the mouth of the artery. And a valve is fixed at the mouth of each of the great arteries that take the blood from the heart, leaving the passage free so long as the blood moves forward, and closing it whenever, because of the relaxation of the ventricle, the blood would otherwise flow back. [Paley goes into a great deal of detail about how these valves are structured and how they operate, and he exclaims 'Can anyone doubt of contrivance here, or is it possible to shut our eyes against the proof of it?']

We cannot consider without gratitude how happy it is that our vital motions are involuntary. We would have enough to do if we had to keep our hearts beating and our stomachs at work!

It might be expected that an organ of such central and primary importance as the heart is would be defended by a case. Indeed, a membranous bag made of tough materials is provided for it, loosely holding the heart within its cavity, guarding its substance without confining its motion, and containing just enough water to keep the surface of the heart supple and moist. How could such a loose covering be generated by the action of the heart? Does not this enclosing of the heart in a sack show the *care* that has been taken for its preservation?

One use of the circulation of the blood (probably among others) is to distribute nourishment throughout the body. How minute and multiplied the ramifications of the blood-vessels are for that purpose, and how thickly spread, at least over the body's surface, is shown by the fact that we cannot prick a pin into the flesh without finding a blood-vessel. Similarly with the body's interior. Blood-vessels run along the surface of membranes, pervade the substance of muscles, penetrate the bones. Every tooth, even, has a small hole in the root, allowing an artery to feed the bone and a vein to bring back the spare blood from it; and these two, with the addition of an accompanying nerve, constitute a thread only a little thicker than a horse-hair.

The intestinal system

This introduces another large topic, namely the way the aliment gets into the blood. This is a subject distinct from the preceding, and brings us to the consideration of another entire system of vessels.

(2) First, the food descends by a wide passage into the intestines, undergoing two great preparations on its way, one in the mouth by chewing and moisture, the other by digestion in the stomach itself. I say nothing about the second, because it is •chemistry and I want to display •mechanism. The shape and position of the human stomach are just right for detaining the food long enough for the action of its digestive juice. As for the bile or pancreatic juice, setting aside its chemistry I offer this about its mechanism: from the glands in which these secretions are developed, pipes run to the first of the intestines, where the product of each gland is mixed with the aliment almost as soon as it passes the stomach.

Secondly, we now have the aliment in the intestines, converted into pulp; and though recently consisting of ten different foods it is reduced to a nearly uniform substance, and to a state fitted for yielding its essence, which is called 'chyle' (which is more like milk than anything else). For straining off this fluid from the digested aliment in the course of its long progress through the body, myriads of pipes as small as hairs open into the cavity of every part of the intestines. These tubes, called 'lacteals', soon unite into larger branches; and the pipes formed by this union terminate in glands, from which other larger pipes carry the chyle from all parts into a common reservoir or receptacle that is big enough to hold about two tablespoons full. From this a duct runs up the back part of the chest, then creeping along the gullet till it reach the neck. Here it discharges itself into a large vein, which soon conveys the chyle—now flowing along with the old blood—to the heart. This whole route can be exhibited to the eye ·when a corpse is dissected·; there is no need for imagination or conjecture. This structure, collectively considered, is obviously dedicated to a necessary purpose; and some aspects of it show the *perfection* of its contrivance.

a In human beings the intestine is six times as long as the body. This prolixity of gut does not seem necessary for the transfer of the material; but the length of the canal is obviously useful because it allows chyle that escapes the lacteals of one part of the guts to be taken up by others further on. **b** The intestine's motion is peristaltic: contractions following one another like waves on the surface of a fluid, quite like an earthworm crawling along the ground. This is brought about by the joint action of longitudinal fibres and of a great number of semicircular ones. This remarkable action pushes forward the grosser part of the aliment, while the more finely divided chyle is gently squeezed into the narrow orifices of the lacteal veins. **c** These lacteals, or at least their mouths, needed to be as narrow as possible, so as to prevent entry into the blood of any particle big enough to create a blockage in a small artery and thus obstruct the circulation; and accordingly their orifices opening into the intestines are too small to be discernible even by the best microscope. Also, because the lacteals are so thin, there have to be incalculably many of them. **d** The chyle enters the blood at an odd place, but perhaps the most best place possible, namely at a large vein in the neck, from which it can speedily to bring the mixture to the heart. This seems to be important; for if the chyle entered the blood at an artery, or at a distant vein, the mixture of old blood and recent chyle would perform a considerable part of the circulation before getting the churning in the lungs that is probably required for the mixture to be perfect. Who could have dreamed that all nourishment is delivered to the body through a communication between the cavity of the intestines and the left great vein of the neck?

A chemical interlude: digestion

I *postponed* discussion of digestion so as not to interrupt my tracing of the passage of the food to the blood; but in treating of the alimentary system I cannot *omit* such a principal part of the system.

The immediate agent by which food is changed in our stomachs is the *gastric juice*. I shall take my account of it from the numerous careful and varied experiments of the Abbé Spallanzani:

(a) It does not merely dilute; it dissolves. A quarter of an ounce of beef had scarcely touched the stomach of a crow when the dissolution began.

(b) It does not have the nature of saliva, or of bile; it is distinct from both. Experiments out of the body show that neither of these secretions acts on alimentary substances in the way the gastric juice acts.

(c) Digestion is not putrefaction; for the digesting fluid stubbornly resists putrefaction—indeed it not only checks its further progress but restores putrid substances.

(d) It is not a process of fermentation; for the dissolving begins at the surface and proceeds towards the centre, contrary to the order in which fermentation acts and spreads.

(e) It is not the digestion of *heat*; for, the cold maw of a cod or sturgeon will dissolve the shells of crabs or lobsters, which are harder than the sides of the stomach containing them.

In short, animal digestion seems to be a power and a process completely *sui generis*, distinct from every other chemical process we know about. And the most wonderful thing about it is its suitability to the particular economy of each animal. [Then a lot of detail about how the differences in •the food of birds of prey, sparrows, poultry, sheep and cows are matched with differences in •the selective powers of their gastric juices and in •the mechanical arrangements for bringing the juices to bear on the food. In these cases, Paley says, what is needed—and provided—is 'a combination of mechanism and chemistry'.] But to return to our hydraulics.

Back to mechanism: bile and saliva

(3) The gall bladder is a very remarkable contrivance. It is the reservoir of a canal. It does not form the channel giving direct communication between the liver and the intestine, which is provided by another passage. The gall bladder lies adjacent to this channel, joining it by a duct of its own, which enables it to increase, as occasions may require, the flow of bile into the duodenum. In its natural situation, it touches the exterior surface of the stomach, and consequently is compressed when the stomach is distended; this has the effect that when the repletion of the stomach by food is about to create a need for an extraordinary quantity of bile, this quantity is forced out from the gall bladder and sent into the duodenum.

The entrance of the gall duct into the duodenum provides another observation. Whenever •smaller tubes are inserted into larger ones, or •tubes are inserted into vessels and cavities, with the receiving tubes or cavities being subject to muscular constriction, we always find a contrivance to prevent regurgitation. In some cases valves are used; with the gall duct (and also the ureters) something different is resorted to. The gall duct enters the duodenum obliquely; after it has pierced the first coat, it runs for an inch or two between the coats before opening into the cavity of the intestine. This structure mechanically resists regurgitation; for any force acting in such a direction as to urge the fluid back into the orifice of the gall duct must at the same time stretch the coats of the duodenum and thereby compress the part of the duct that lies between them.

(4) The pipe conveying the saliva from where it is made to the place where it is wanted deserves to be counted among the most intelligible pieces of mechanism that we know about. Although the saliva is used in the mouth, much of it is produced on the outside of the cheek by a gland lying between the ear and the angle of the lower jaw. Running from that gland there is a pipe, about the thickness of a wheat straw and about two inches in length; after riding over the masseter muscle, this bores for itself a hole through the very middle of the cheek, through which it discharges its fluid very copiously into the mouth.

The windpipe

(5) Another exquisite structure is seen in the larynx. Unlike the preceding four, it does not concern the conveyance of fluids, but it is like them in being one of the vessels of the body. We all know that two pipes go down the throat—one to the stomach for food, the other to the lungs for breathing and speaking—each with an opening at the bottom of the mouth. With these being so close to one another, the problem was to prevent food, especially liquids, from entering the windpipe, i.e. the road to the lungs. When this error *does* happen, it instantly produces convulsive throes. The problem is elegantly solved as follows. The gullet (the passage for food) opens into the mouth like the cone of a funnel, the capacity of which does indeed constitute the bottom of the mouth. Into the side of this funnel, at the lowest part, the windpipe enters through a chink or slit, with a lid snugly fitted to the opening. The solids or liquids that we swallow pass over this lid as they descend by the funnel into the gullet; and while this is happening the lid is kept closed by the weight of the food and the action of the muscles involved in swallowing. When the food has passed ·and the swallowing stopped·, the natural cartilaginous spring of the lid goes into action, raising the lid a little and allowing a free inlet and outlet for the respiration of air by the lungs. Notice how seldom this expedient fails of its purpose, compared with how often it succeeds. Think how often we swallow, how constantly we breathe, and what a commotion there is when one person allows a crumb or a drop into his windpipe!

This structure cannot have been gradually developed through a succession of generations. The action of the parts has no tendency to form such a thing; and anyway the animal could not live while it was only half formed. The species could not wait for the gradual formation or expansion of a part that was from the outset necessary to the life of the individual.

The whole windpipe has a structure adapted to its particular office. It is made up (as you can perceive by putting your fingers to your throat) of strong cartilaginous ringlets, placed at small and equal distances from one another. These serve to keep the passage for the air constantly open, which they do mechanically. A pipe with soft walls, liable to close when empty, would not have been appropriate here. It is what the body's numerous other conduits are like, and it serves very well for tubes that are kept distended by the fluid they enclose, or provide a passage to solid and protruding substances.

It is notable that these ringlets are not cartilaginous and stiff all around; the part of them that is contiguous to the gullet is membranous and soft, easily yielding to the distentions of the gullet when solid food goes down.

The constitution of the windpipe suggests another reflection. Its inside is lined with what may be the most sensitive, irritable membrane of the body. It reacts to the touch of a crumb of bread or a drop of water with a spasm that convulses the whole frame; yet when it is left to itself and to its proper office of letting in air alone, nothing can be so quiet. It does not even make itself felt; a man does not know that he *has* a trachea. One might have thought it unlikely that a single organ would have both these properties: **a** extreme sensitivity when intruded upon, and **b** perfect rest and ease when left alone. But it is to the combination of these almost inconsistent qualities—in this and some other delicate parts of the body—that we owe our safety and our comfort; our safety to their **a** sensitivity, our comfort to their **b** repose.

[Paley closes the section with some remarks about the role of the lungs and windpipe in song and speech.]

Mechanisms: summing up

Wanting to be methodical, I have considered animal bodies under three divisions—their bones, their muscles, and their vessels—and have made my case in relation to these parts in three separate chapters. But the Creator's wisdom is seen not in their separate but in their collective action, in their mutual subservience and dependence, in their combining to produce single effect. It has been said that a man cannot lift his hand to his head without finding enough to convince him of the existence of a God. That is well said; for he has only to reflect on how many things are needed for performing this familiar and seemingly simple action:

- a long, hard, strong cylinder, to give to the arm its firmness and tension;
- joints for moving the arm, one at the shoulder to raise it and one at the elbow to bend it, these being continually fed with a soft mucilage to make the parts slip easily on one another, and held together by strong braces to keep them in their position;
- muscles and tendons, artfully inserted for the purpose of pulling the bones in the directions the joints allow them to move in.

Up to here we seem to understand the mechanism pretty well; and our understanding of it provides enough for my conclusion. But so far we have only a machine standing still, a dead organisation, an apparatus. To put the system to work, something further must be provided, namely a communication with the brain by means of nerves. We know the existence of this communication, because we can see the communicating threads, and can trace them to the brain; and we also know its necessity, because if the thread is cut, the muscle becomes paralytic. We don't know much more than that, because the organisation is too minute and fine-grained for our inspection.

The single act of a man's raising his hand to his head requires not only all the above but also everything needed for the growth, nourishment and maintenance of the limb, the repair of its waste, the preservation of its health—the circulation of the blood through every part of it; its lymphatics, exhalants, absorbents; its excretions and integuments. All these contribute to the result, join in the effect. It is impossible to conceive how any of these—let alone *all* of them—could collaborate without a designing, disposing intelligence.

11. The animal structure seen as a mass

Contemplating an animal body in its collective capacity, we must notice how many instruments are brought together, often within how small a compass. It is a cluster of contrivances. In a canary, for instance, in the single ounce of matter that composes its body, there are instruments for eating, digesting, nourishment, breathing, generation, running, flying, seeing, hearing, smelling—each appropriate for its purpose, each entirely different from all the others.

The animal frame, considered as a mass or assemblage, has in its composition three properties that have long struck me as indubitable evidences not only of design but of a great deal of attention and accuracy in carrying out the design. ·They will be the subjects of the next three sections·.

Symmetry and asymmetry

The first is, the exact correspondence of the two sides of the same animal; the right hand corresponding to the left, leg to leg, eye to eye, one side of the face to the other; and with a precision that is very difficult for a sculptor to imitate at all closely.

It is hard to get a wig made even, yet how seldom is the face awry! And the anatomy of its bones demonstrates what care is taken to preserve its symmetry. The upper part of the face is composed of thirteen bones, six on each side, matching each to each, and the thirteenth, with no partner, in the middle; the lower part of the face is similarly composed of six bones, three on each side, with the lower jaw in the centre. Could the builder of an arch do more to make the curve true, i.e. the parts equidistant from the middle, alike in shape and position?

Given how complex the eyes are in their structure, how various and delicate are the shades of colour that the iris is tinged with, how differently—so far as appearance is concerned—different eyes are mounted in their sockets in different heads, the resemblance of each eye to its partner is a property of animal bodies much to be admired. Of ten thousand eyes, I do not know that we could match one except with its own partner, or sort them into suitable pairs by any selection except the one that obtains.

This regularity of the animal structure is rendered more remarkable by the three following considerations.

a The individual limbs do not have not this correlation of parts, but the contrary of it. A knife drawn down the middle cuts the human body into two parts, externally equal and alike; you cannot draw a straight line that will divide a hand, a foot, the leg, the thigh, the cheek, the eye, the ear, into two parts equal and alike. The parts that are located on the middle line of the body, such as the nose, the tongue, the lips, can be so divided, but other parts cannot. This shows that the correspondence I have been describing does not arise necessarily from the nature of the subject; for if it did, it would be universal; whereas it is observed only in the system or assemblage, not in the separate parts. It is found where it conduces to beauty or utility; it is not found where it would detract from both. The two wings of a bird always correspond; the two sides of a feather frequently do not. In centipedes and their like, no two legs on the same side are alike, yet there is the most exact similarity between the legs opposite to one another.

b While the cavities of the body are so configured as to exhibit *externally* the most exact correspondence of the opposite sides, the *contents* of these cavities have no such correspondence. A line drawn down the middle of the breast divides the thorax into two exactly similar sides, but these sides enclose very different contents. The heart lies on the left side, a lobe of the lungs on the right, with no match in size or shape. The same thing holds for the abdomen. The liver lies on the right side, without any similar organ matching it on the left; the spleen, which is indeed situated over against the liver, doesn't resemble it in size or shape.

c An internal inequality in the feeding vessels is so managed as to produce no inequality in parts that were intended to correspond. The right arm answers accurately to the left, both in size and shape; but the arteries supplying the two arms do not go off from their trunk in a pair, in the same manner, at the same place, or at the same angle. Given this dissimilarity, it is very difficult to conceive how the same amount of blood would be pushed through each artery; yet so it is—the two limbs nourished by them perceive no difference of supply, no effects of excess or deficiency.

Packaging

Another surprising perfection of the animal mass is the package. Examine the contents of the trunk of any large animal, and notice how soft and intricate they are, how constantly in action, how necessary to life! Reflect on the danger of any injury to their substance, any change of their position, any obstruction to their office. Observe

- •the heart pumping at the rate of 80 strokes a minute, with one set of pipes carrying the stream away from it, another bringing it back;
- •the lungs performing their elaborate office, distending and contracting their many thousand vesicles by an alternation that cannot cease for a minute;
- •the stomach exercising its powerful chemistry;
- •the bowels silently propelling the changed aliment; collecting from it and transmitting to the blood an incessant supply of prepared nourishment;
- •that blood pursuing its course, with many glands—including the liver, the kidneys and the pancreas—drawing off from it their proper secretions.

All these operations, and others less capable of being investigated, are going on within us all at once. Think of this; and then observe how the body itself—the case that holds this machinery—is rolled and jolted and tossed about, with the mechanism remaining unhurt and with very little effect on even its most delicate motions. Observe this, and then reflect how firmly every part must be secured, how carefully surrounded, how well tied down and packed together!

This property of animal bodies seems never to have been considered as a separate topic, or as fully as it deserves. So allow me to support my remarks about it by briefly presenting anatomical details, though this obliges me to use more technical language than I would wish to introduce into a work of this kind. [Paley devotes about three pages to this, with details concerning •the heart, 'placed between two soft lobes of the lungs'; the lungs, 'tied to the sternum before and to the vertebrae behind'; the liver, 'fastened by two ligaments', one for holding the liver in place when our body is erect, the other for when we are lying down; •the bladder, 'tied to the navel by a ligament, so that what was a passage for urine to the fetus becomes after birth a support for the bladder'; •the kidneys, 'lodged in a bed of fat'; •the pancreas, 'strongly tied to the peritoneum'; •the spleen, confined to its place by an adhesion to the peritoneum and diaphragm'; and •the brain, whose septa 'probably prevent one part of that organ from pressing with too great a weight on another part'. He continues:] The great art and caution of packing is to prevent one thing from hurting another. In an animal body's head, chest and abdomen this is provided for—among other methods—by membranous partitions and wrappings that keep the parts separate.

The above may serve as a short account of how the principal viscera are kept in their places. But the most curious [see Glossary] provision for this purpose, in my opinion, and also the most needed, is in the guts. It is pretty evident that a long narrow tube (in man, about five times the length of the body)—

•laid in folds,

•winding in oblique and circuitous directions, and

•composed of a soft and yielding substance

—must be continually displaced by the sudden motions of the body that contains it, unless extraordinary precaution is employed its safety. The expedient provided for this is admirable. The intestinal canal, throughout its length, is knit to the edge of a broad fat membrane called the mesentery. It forms the margin of this mesentery, being fastened to it like the edging of a ruffle; it is four times as long as the mesentery itself, and is 'puckered or gathered on' to it as a seamstress would say. The mesentery is wide and thick, making it capable of a folding that is more close and safe than the intestinal tube would admit of if it had remained loose. This membrane, which appears to be the great support and security of the alimentary apparatus, is itself strongly tied to the first three vertebrae of the loins.

Beauty

A third general property of animal forms is *beauty*. I do not mean the beauty of one individual compared with another of the same species, or of one species compared with another species. What I am talking about is the provision that is made in the body of almost every animal to make its appearance acceptable to the animals it comes into contact with. In our own species, for example, consider the parts and materials the fairest body is composed of, and you will realise how well these things are wrapped up so as to form a mass that has symmetry in its proportion and beauty in its aspect: how the bones are covered, the bowels concealed, the roughnesses of the muscle smoothed and softened; and the whole is covered by an integument that converts the disgusting materials of a dissecting-room into something that can be looked on with affection or at least with ease and satisfaction. Much of this comes from the intervention of the cellular membrane that lies immediately under the skin as a kind of lining to it. This is moist, soft, slippery, and compressible, filling up all the interstices of the muscles and forming thereby their roundness and flowing line, as well as the evenness and polish of the whole surface.

This seems to be a strong indication of design, and of a design carefully directed to this purpose. And given that such a purpose exists with respect to any of nature's productions, we may with a considerable degree of probability assign other particulars to the same intention—the tints of flowers, the plumage of birds, the furs of beasts, the bright scales of fishes, the painted wings of butterflies and beetles, the rich colours and spotted lustre of many tribes of insects.

There are ornamental parts of animals whose beauty-making properties do not serve any other purpose that we know of. The irises of most animals' eyes are very beautiful, without their beauty conducing at all to the perfection of vision.

In plants, especially in their flowers, the principle of beauty holds a still more considerable place in their composition; is even more open than in animals. To take just one instance (there are hundreds), why does the corolla of the mature tulip change its colour? So far as we can see, the purposes of vegetable nutrition could have been carried on as well by its staying green. This has been called a disease of the plant, but that seems to be a lame account. Is it not more probable that this property, which seems to be independent of the needs and utilities of the plant—was calculated for beauty, intended for display?

It has been maintained that there is no such thing as beauty; that things come to be thought beautiful only because they are useful and familiar. Our idea of beauty can be so greatly modified by habit, fashion, the experience of advantage or pleasure, and associations arising out of that experience, that it has been suggested that it has been altogether generated by these causes and would have no existence without them. This seems to reach a conclusion that goes too far from its premises. I would rather argue as follows. The question concerns objects of •sight. Now, every other sense has its distinction of agreeable and disagreeable. Some •tastes offend the palate, others gratify it, even more strongly and regularly in brutes and insects than in man. Similarly, •smells affect the nose with sensations that are pleasurable or disgusting. Some •sounds or combinations of sounds delight the ear, others torture it. Habit can do much in all these cases (which is just as well for us, for habit reconciles us to many necessities); but does the distinction of agreeable and disagreeable have no foundation in the sense itself? What is true of the other senses is probably true of the eye (the analogy is irresistible), namely that it has an **original** constitution that is fitted to receive pleasure from some impressions and pain from others.

But I do not know that my argument alleging beauty as a final cause [see Glossary] requires me to claim so much. We do have a sense of beauty, however we come by it; it does in fact exist. Things are not indifferent to this sense; all objects do not suit it; many are agreeable to it, many others disagreeable. It is certainly not the effect of habit on the particular object, because the most agreeable objects are often the most rare; and many that are very common continue to be offensive. If they be made tolerable by habit, that is the most it can do; they never become agreeable. So if this sense is not original [see Glossary] but **acquired**, that is the outcome of numerous complicated actions of external objects on the senses, and of the mind on its sensations. With this result there must be a certain congruity to enable any particular object to please: and that congruity, we contend, is consulted in the aspect which is given to animal and vegetable bodies. [That last sentence is verbatim as Paley wrote it.]

The skin and covering of animals is what their appearance chiefly depends on, and is in all animals the part most decorated and free from impurities. But even if beauty had no place here, the throwing of an integument over the collocation of the parts of the body beneath it has another purpose—a even more important one—namely concealment. Were it possible to view through the skin the mechanism of our bodies, the sight would frighten us out of our wits. A lively French writer says: 'Would we dare to make a single movement if we saw our blood circulating, the tendons pulling, the lungs blowing, the humours filtrating, and all the incomprehensible assemblage of fibres, tubes, pumps, valves, currents, pivots, that sustain an existence that is at once so frail and so presumptuous?'

Standing

Animal bodies considered as masses have another property that is more curious than it is generally thought to be, namely the ability to *stand*. This is more remarkable in two-legged animals than in quadrupeds, and especially in man—the tallest, with the smallest base. The statue of a man, placed loosely on its pedestal, would not be upright for half an hour. If you don't fix its feet to the block by bolts and solder, the first gust of wind is sure to topple it. Yet this statue has all the mechanical proportions of a living man. So what keeps a man upright is not merely his shape or the relation of his centre of gravity to his base. Either the law of gravitation is suspended in favour of living substances, or something more is done for them to enable them to uphold their posture. There is no reason to doubt that their parts descend by gravitation as do the parts of dead matter. The 'something more' appears to me to consist in a capacity for perpetually shifting the centre of gravity, by a set of quick-balancing actions (obscure ones indeed), so as to keep within its prescribed limits the line from that centre to the ground. Of these actions it may be observed **a** that they in part constitute what we call strength. The dead body drops down. The mere adjustment therefore of weight and pressure, which may be the same the moment after death as the moment before, does not support the column; an in cases of extreme weakness, the patient cannot stand upright. **b** Also, these actions are only in a small degree voluntary. A man is seldom conscious of his voluntary powers in keeping himself on his legs. A child learning to walk is the greatest posture-master in the world; but the art (so to call it) sinks into habit, and the child is soon able to poise himself in a great variety of attitudes without being aware of either caution or effort. But there must be an aptitude of parts that habit can get hold of, a pre-habit capacity for motions that the animal is thus taught to exercise; and one of the things we wonder at it how easily this exercise is acquired. What parts are principally employed, and how each contributes its office, is difficult to explain. Perhaps the obscure motion of the bones of the feet have a share in it; they are put in action by every slip or vacillation of the body, and seem to assist in restoring its balance. The alternation of the joints (the knee-joint bending backward, the hip-joint forward) and the flexibility in every direction of the spine appear to be very important in preserving the body's equilibrium. Also a certain degree of tension in the sinews appears to be essential to an erect posture; for it is by the loss of this that the dead or paralytic body drops down. The whole is a wonderful result of combined powers and complicated operations. That *standing* is not as simple a business as we imagine it to be is evident from the strange movements of a drunken man who has lost control of his centre of gravity.

I have said that this property is most noteworthy in the human body; but a bird resting on its perch or hopping onto a branch provides a non-trivial example of the same faculty. Considered geometrically and with relation to its centre of gravity, its line of direction and its equilibrium, a chicken is a very irregular solid; but as soon as it is hatched from the egg it runs off. This cannot be something it has been taught. Can we not say that *nature* has balanced the chicken's body on its pivots?

Interrupted analogies

I shall present here ·three· examples of *patterns followed and then dropped*, which I call 'interrupted analogies'. I do not know how such critical deviations can possibly be accounted for without *design*.

(a) All the bones of the body are covered with a periosteum except the teeth. With them it ceases, and is replaced by an enamel of ivory that saws and files will hardly affect. No-one can doubt the use and propriety of this difference, of the rule for the conformation of the bones stopping where it does stop, of the 'analogy' being thus 'interrupted'. For if such an acutely sensitive membrane as the periosteum had covered the teeth as it does every other bone in the body, the animal would have been in continual pain because of the necessary exposure of the teeth. What *they* needed was a strong, hard, insensitive, defensive coat; and that is exactly what they are provided with by the ivory enamel that adheres to their surface.

(b) The epidermis that clothes all the rest of the body gives way at the extremities of the toes and fingers to nails. Just look at your hand to see how precisely the covering that extends over every other part is here superseded by a different substance with a different texture. Now, if **a** the rule had been necessary or **b** the deviation from it accidental, this effect would not be seen. **a** If the formation of the skin on the surface were produced by a set of causes constituted without design, acting by a general operation, no explanation could be given for the operation's being suspended at the fingers' ends, or on the back part of the fingers and not on the other part. **b** If the deviation were accidental—an error, an anomaly, anything but intentional—we would find nails on other parts of the body; they would be scattered over the surface, like warts or pimples.

(c) All the great cavities of the body are enclosed by membranes, except the skull. Why should not the brain be content with the same covering as the other principal organs of the body have? The heart, the lungs, the liver, the stomach, the bowels, all have soft integuments and nothing else. Their muscular coats are all soft and membranous. I can see a reason for this distinction in the final cause, but in no other.

The importance of the brain to life, and the extreme tenderness of its substance, give it a greater need for a solid case than any other part has; and that is what the hardness of the skull supplies. When the smallest portion of this natural casing is lost, how carefully yet how imperfectly is it replaced by a metal plate! There are other bony cavities in the body, but the skull differs from them in two ways: the bony covering completely surrounds its contents, and it is aimed not at motion but solely at defence. Also, the hollows and inequalities that we observe in the inside of the skull, exactly fitting the folds of the brain, serve the important purpose of keeping the substance of the brain steady and of guarding it against concussions.

12. Comparative anatomy

When we find a general plan being followed, with variations required by the particular demands of the subject to which it is applied, this gives us the strongest evidence—almost *conclusive* evidence—of intelligence and design. If the general plan proceeded from any fixed necessity in the nature of things, how could it accommodate itself to the various wants and uses which it had to serve under different circumstances, and on different occasions? [He likens this to a mill designed for spinning cotton and adapted for spinning wool, flax, and hemp, which provides overwhelming evidence that] intelligence, properly and strictly so called (including foresight, consideration, reference to utility) was at work in the original plan as well as in the changes and adjustments it is made to undergo.

Much of this reasoning is applicable to so-called *comparative anatomy*. Between all large terrestrial animals there is a close resemblance in their general economy, the outlines of the plan, the construction as well as offices [see Glossary] of their principal parts. Life is sustained and the body nourished by nearly the same apparatus in all of them. The heart, the lungs, the stomach, the liver, the kidneys are much alike in all. The same fluid (for no differences in kinds of blood have been observed) circulates through their vessels, and nearly in the same order. When we pass on to smaller animals, or to the inhabitants of a different element, the resemblance becomes more distant and more obscure; but still the plan accompanies us.

My present concern is to bring out how the general plan is varied and deflected by special occasions and utilities.

Coverings, especially feathers

I do not know whether I am correct in classing animals' covering under their 'anatomy', ·but it belongs in this chapter anyway·. The covering of different animals is the first thing that presents itself to our observation; and it is as much to be admired as any part of their structure, because of its variety and its suitableness to their various natures. There are bristles, hair, wool, furs, feathers, quills, prickles, scales; yet in this diversity both of material and form we cannot change one animal's coat for another without obviously changing it for the worse. (These coverings incidentally, are in many cases armour as well as clothing, intended for protection as well as warmth.)

The human animal is the only naked one, and the only one that can clothe itself. This is one of the properties that makes him an animal of all climates and all seasons. He can adapt the warmth or lightness of his covering to the temperature of his habitation. Had he been born with a fleece on his back, although he might have been comforted by its warmth in high latitudes, it would have oppressed him by its weight and heat as the species spread towards the equator.

What art [see Glossary] does for men has been done by nature for many animals that are incapable of art. Their clothing, of its own accord, changes with their necessities. This is particularly the case with the large tribe of quadrupeds covered by furs. Every dealer in hare skins and rabbit skins knows how much the fur is thickened by the approach of winter. It seems to be a part of the same design that in hot countries wool gives way to hair, whereas in dogs of the polar regions hair is replaced by wool or something very like it.

We know the final cause [see Glossary] of all this, and we know no other cause.

The covering of birds—

- •its lightness,
- •its smoothness,
- •its warmth,
- •the lay-out of the feathers, all inclined backward, the down about their stem, the overlapping of their tips,
- •their different configuration in different parts, and
- •the variety of their colours

—constitute a vestment for the body that is so beautiful, and so appropriate to the life the animal is to lead, that I don't think we can imagine anything more perfect, or could have imagined anything *this* perfect if we had never seen it.

This is one of those cases where the philosopher [here = 'scientist'] has more to admire than the common observer. Every feather is a mechanical wonder. The quill has strength and lightness—properties not easily brought together. I know few things more remarkable than the strength and lightness of the pen I am writing with right now. If we look at the upper part of the stem, we see a material made for the purpose and not used in any other class of animals or in any other part of birds: tough, light, pliant, elastic.

But the artificial [see Glossary] part of a feather is the beard. The 'beards' are what are fastened on each side of the stem and constitute the breadth of the feather; what we usually strip off from one side or both when we make a pen. The separate pieces or laminae of which the beard is composed are called 'threads' or 'filaments'. The first thing an attentive observer will notice is how much stronger the beard of the feather is when pressed in a direction perpendicular to its plane than when it is rubbed up or down in the line of the stem. And he will soon discover the structure that leads to this difference, namely that the laminae these beards are composed of are flat, and placed with their flat sides towards each other; so that while they easily bend to approach each other (as anyone can find by drawing his finger lightly upwards), they are much harder to bend out of their plane; and the latter is the direction in which they have to encounter the impulse and pressure of the air, and in which their strength is needed and put to the test.

A second special feature of a feather's structure is even more extraordinary. Whoever examines a feather cannot help noticing something about the threads or laminae of which I have been speaking, namely that

- in their natural state they hold together,
- their union is more than the mere apposition of loose surfaces,
- it takes some degree of force to pull them apart, yet
- there is nothing like glue between them;

so that by some mechanical means they catch or clasp among themselves, thereby giving to the beard its closeness and compactness of texture. Furthermore, when two laminae that have been separated by accident or force are brought together again, they immediately reclasp; the connection, whatever it was, is perfectly recovered and the beard of the feather becomes as smooth and firm as if nothing had happened to it. Try it for yourself.

The mechanism by which this remarkable contrivance is brought about is easy to see with a microscope:

> The threads or laminae are *interlaced* with one another, through a vast number of fibres that grow out from each side of the laminae and hook and grapple together. (A friend of mine counted fifty of these in one twentieth of an inch.) The fibres that come from the lamina on the side towards the tip of the feather are longer, more flexible, and bent downward; those that come from the side towards the feather's quill-end are shorter, firmer, and turned upwards. What happens is this: when two laminae are pressed together enough for the long fibres to be forced over the short ones, their crooked parts fall into the cavity made by the crooked parts of the others; just as the latch on a door enters the cavity of the catch fixed to the doorpost, and thereby fastens the door. It is strictly in this way that one thread of a feather is fastened to the next.

This admirable structure of the feather succeeds perfectly for the use nature has designed it for; not only that the laminae might be united, but that when one lamina has been separated from another by some external violence it might be easily and quickly reclasped.

In the small order of birds that winter with us, from the snipe downwards, whatever the external colour of their feathers is, their Creator has given them all a bed of black down next their bodies. Black is the warmest colour; and the purpose here is to keep in the heat arising from the heart and the circulation of the blood. It is noteworthy that this is not found in larger birds, because larger birds are much less exposed to the cold than small ones. [He explains why: the smaller the bird, the larger its surface in relation to its bulk. For a wren, the area of surface for each cubic inch of body is about ten times what it is for a turkey.] So small birds had to be more warmly clad than large ones, and the bed of black down seems to be the expedient by which that need is provided for.

Mouths

In comparing different animals, I know no part of their structure that exhibits greater variety, or a more precise fitting of that variety to their respective convenience, than their mouths. Whether the purpose is merely taking in food or

- catching prey,
- picking up seeds,
- cropping herbage,
- extracting juices,
- sucking in liquids,
- breaking and grinding food,
- tasting the food,

together with breathing in air and uttering sounds, these various offices are assigned to this one part, and are provided for by different constitutions in different species. In the human species, because there are hands to convey the food to the mouth, the mouth is flat and thus fitted only for reception; whereas the projecting jaws, wide mouth and pointed teeth of the dog and its relatives enable them to use their mouths to snatch and seize the objects of their pursuit. The full lips, rough tongue, corrugated cartilaginous palate and broad cutting teeth of the ox, the deer, the horse, and the sheep qualify this tribe for browsing on their pasture. The recessive under-jaw of a swine works in the ground, after the protruding snout, like a prong or plough-share, has made its way to the roots on which it feeds. Such a satisfactory conformation was not the gift of chance!

In birds this organ takes on a new character—new in substance and in form, and in both wonderfully adapted to the wants and uses of a distinct way of life. In place of the fleshy lips and teeth of enamelled bone, birds have a hard substance cut out into proper shapes and mechanically suited to the actions that are wanted. The sharp edge and tempered point of the sparrow's bill picks almost every kind of seed from its concealment in the plant, and then hulls the grain, breaks and shatters the coats of the seed, in order to get at the kernel. The hooked beak of the hawk tribe separates the flesh from the bones of the animals it feeds on, almost as cleanly and precisely as a dissector's knife. [He goes on to describe other kinds of beak and the uses to which they are put: butcherbird, goose, snipe and woodcock, and 'birds that live by suction'. These last, he reports, have filters inside the beak and near its edge.]

The likeness of the bills of birds to the mouths of quadrupeds suits my argument exactly: it is close enough to show the continuation of the same plan, and remote enough to show that the difference is not produced by action or use. A more prominent contour or a wider mouth might be explained as resulting from the species continually trying to thrust out the mouth or open it to the stretch. But by what course of exercise or endeavour can we get rid of the lips, the gums and the teeth, and acquire in their place pincers of horn? By what habit can we so completely change not only the part's shape but also the substance it is composed of? Everything about the animal mouth is mechanical. The teeth of fish have their points turned backward, like the teeth of a wool or cotton card; the teeth of lobsters work one against another, like the sides of a pair of shears; in many insects the mouth is converted into a pump or sucker, equipped to bore through the integuments of the insect's prey and then extract its juices. And—most extraordinary of all—one sort of mouth changes into another sort as the occasion requires. The caterpillar could not live without teeth; in several species, the butterfly formed from it could not use them. The old teeth therefore are cast off with the exoskeleton of the grub, and a quite different apparatus takes their place in the fly.

We sometimes forget that through all these novelties of form it is the animal's *mouth*, that whether it be lips, or teeth, or bill, or beak, or shears, or pump, it is the same part diversified.

Gullet and intestine

In the gullet also, comparative anatomy reveals a difference of structure adapted to the different needs of the animal. In brutes [see Glossary], because the posture of their neck doesn't much help the passage of the food, the fibres of the gullet, which act in this business, run in two close spiral lines, crossing each other; in men these fibres run only a little obliquely from the upper end of the esophagus to the stomach, into which by a gentle contraction they easily transmit the descending morsels. That is, for the more laborious swallowing of animals that thrust their food up instead of down, and also through a longer passage, a correspondingly more powerful apparatus of muscles is provided. It is more powerful not merely by the strength of the fibres, which might be attributed to the greater exercise of their force, but in their placing, which must have been original.

The gullet leads to the intestines, and here again, comparing quadrupeds with man, we find a general similarity with appropriate differences. The *valvuae conniventes* (which some call the 'semilunar valves') found in the human intestine are lacking in that of brutes. These are wrinkles in the innermost coat of the guts, which slow down the movement of the food through the alimentary canal. It is easy to understand how much more necessary such a provision is to **a** the body of an animal with an erect posture, where the weight of the food is added to the action of the intestine, than to **b** the body of a quadruped, where the food's journey from entrance to exit is nearly horizontal; but to explain why this difference actually exists we have to resort to the final cause. Mightn't the system of wrinkles have been caused by the action of the intestine? No! If it were, we would find it in **b** quadrupeds rather than in **a** men.

We should attend to the different length of the intestines in carnivorous and herbivorous animals. The shortest, I believe, is that of some birds of prey in which the intestinal canal is little more than a straight passage from the mouth to the anus. The longest is in the deer kind. The intestines of a four-feet-high Canadian stag measure 96 feet. The intestine of a sheep, unravelled, measures 30 times the length of the body. The intestine of a wild cat is only three times the length of the body. Universally, where the substance the animal feeds on is slow to digest, or yields its chyle with more difficulty, there the passage is circuitous, so as to allow time and space for the necessary change and absorption. Where the food is soon dissolved, or already half assimilated, a shorter and a readier route is provided, so as to avoid an unnecessary or perhaps harmful delay.

The special needs of birds

In comparing the bones of different animals, we are struck with how the bones of birds are appropriate in a way that could only come from the wisdom of an intelligent and designing Creator. An animal that is to fly needs bones that are **strong** and **light**. Well, then, how do the cylindrical bones of birds differ in these respects from the bones of quadrupeds? •Their cavities are much larger in proportion to the weight of the bone than in the bones of quadrupeds. •These cavities are empty. •The shell is of a firmer texture than is the substance of other bones. Now, the weight being the same, the diameter will obviously be greater in a hollow bone than in a solid one, and any mathematician can prove that (other things being equal) the greater the diameter of a cylinder the greater its strength, its resistance to breaking. In short, a bone of the same weight would not have been so **strong** in any other form; and making it less **light** would have hampered the animal's flight. This form could not be acquired by use, or the bone become hollow by exercise.

As compared with the lungs of quadrupeds, the lungs of birds also have a feature that is unique to them and conspicuously designed for this same purpose of flight, namely a communication between the air-vessels of the lungs and the cavities of the body. This allows air to pass from one to the other (at the will, apparently, of the animal), so that its body can be occasionally puffed out and its specific gravity—its tendency to descend in the air—made less. The bodies of birds are inflated from their lungs and thus made buoyant.

All birds are oviparous. This carries on the work of gestation with as little increase as possible of the weight of the body. A gravid uterus [i.e. one heavy with fetuses] would have been a troublesome burden to a bird in its flight. The advantage of an oviparous procreation is that, while the whole brood are hatched together, the eggs are laid singly and at considerable intervals. Ten, fifteen, or twenty young birds may be produced in one clutch though the parent bird was never burdened by the load of more than one full-grown egg at a time.

Means of travel

A principal topic of comparison between animals is in their instruments of motion, which we encounter in three categories: feet, wings, and fins. If any of the three is best fitted for its use, which is it? Is it not rather that the same consummate art is conspicuous in them all? Because of differences in the elements in which the motion was to be performed—·ground, air, water·—the Creator had to prepare for different situations and difficulties; but the purpose is accomplished just as successfully in each case as in the others. And as between wings and the legs of quadrupeds it is accomplished without deserting the general idea. The idea is modified, not deserted. Strip a wing of its feathers and it looks significantly like the foreleg of a quadruped. The articulations at the shoulder and the cubitus are much alike, and in both cases the upper part of the limb consists of a single bone, the lower part of two.

But when the wing is fitted up with its equipment of feathers and quills, it becomes a wonderful instrument; and the way the bird uses it in flying is more complicated and more curious [see Glossary] than is generally known. If the flapping of the wings in flight were merely the reciprocal motion of the same surface in opposite directions, the bird would lose as much by its upwards motion as it gained by the downwards one. To account for the advantage the bird derives from its wing, therefore, we must suppose that the surface of the wing (measured on the same plane) is contracted while the wing is drawn up, and let out to its full expansion when it descends. Now, the form and structure of the wing—

- its external convexity,
- the disposition and particularly the overlapping of its larger feathers,
- the action of the muscles, and
- the joints of the pinions

—are all adapted to this alternate adjustment of its shape and dimensions. For example, such a twist is given to the great feathers of the wing that going down they strike the air with their flat side, but rise from the stroke slantwise. The turning of the oar in rowing when the oarsman advances his hand for a new stroke is a similar operation to that of the feather, and takes its name, ·'feathering'·, from the resemblance. This faculty [see Glossary] is not found in the great feathers of the tail, I believe. This is the place to point out that the pinions are set on the body in such a way as to bring down the wings in a direction obliquely tending towards the tail; which motion does two things at once—supports the body in the air and carries it forward. The steering of a bird in its flight is effected partly by the wings, but mainly by the tail. And in this matter we meet with a remarkable circumstance: birds with long legs have short tails; and in their flight place their legs close to their bodies while stretching them out backwards as far as they can. In this position the legs extend beyond the rump and become the rudder, providing the steering that the tail could not.

There is an easy transition from the wings of birds to the fins of fish. They are both instruments of motion, with a considerable difference in the work they have to do, because fish have nearly the same specific gravity as the element they move in, whereas birds do not. So fish have little or no weight to bear up; what is needed is only a sufficient impulse to carry the body through a resisting medium, or to maintain the posture, or to support or restore the balance of the body, which is always the most unsteady where there is no weight to sink it. For these offices, the fins are as large as necessary, though much smaller than wings, their action mechanical, their position and the muscles by which they are moved highly convenient. [Paley goes on to say that this is confirmed by experiments that have been performed on fish, offers a 'short account' of these, and seems untroubled by their vivisectional nature. He then moves on to their upshot:] The pectoral and more particularly the ventral fins serve to raise and lower the fish; when the fish wants to move backwards, a stroke forward with the pectoral fin does that; if it wants to turn either way, a single blow with the tail the opposite way sends it round; if the tail strikes both ways, the double lash moves the fish forwards with an astonishing velocity. The result is not only in some cases the most rapid, but in all cases the most gentle, pliant, easy, animal motion that we are acquainted with. In their mechanical use, the anal fin may be reckoned the keel; the ventral fins, out-riggers; the pectoral muscles, the oars.

We have seen that the tail in the fish is the great instrument of motion. Now, in cetaceous or warm-blooded fish that have to rise every two or three minutes to the surface to breathe, the tail—unlike that of other fish—is horizontal; so its stroke is perpendicular to the horizon, which is the right direction for sending the fish to the top or carrying it down to the bottom.

In looking at animals' instruments of motion, I have followed the comparison only through the first great division into beasts, birds, and fish. If I wanted to go further, I would take in the special feature of the web-foot of water fowl. It is an example that could be pointed out to a child. It is so obvious that webbed feet are useful to water-fowl and would not be to land fowl that it seems impossible to notice the difference without acknowledging the design. I am at a loss to know how those who deny the agency of an intelligent Creator deal with this example. There is nothing in the action of swimming, as carried on by a bird on the surface of the water, that would generate a membrane between the toes. The only supposition I can think of is that all birds were originally water fowl and web-footed, and that sparrows, hawks, linnets, etc. have in the course of many generations had this part worn away by treading on hard ground. To such evasive assumptions must atheism always have recourse!

The five senses

The five senses are common to most large animals. We have not much difference to remark in their constitution, and less that is referable to mechanism.

The superior sagacity of animals that hunt their prey and consequently depend for their livelihood on their nose is well known in its use; but not at all known in the organisation that produces it.

The external ears of beasts of prey have their trumpet part standing forwards, to seize the sounds that are ahead of them, i.e. the sounds of the animals they are pursuing or watching. The ears of animals of flight are turned backward, to give notice of the approach of their enemy from behind. This is a critical distinction, and is mechanical; but it is quite likely to be an effect of continual habit ·rather than an upshot of intelligent design·.

The eyes of animals that follow their prey by night—cats, owls, etc.—have a faculty not given to the eyes of other species, namely of closing the pupil entirely. The final cause of this seems to be as follows. It was necessary for such animals to be able to discern objects with very small degrees of light. This capacity depended on the superior sensitivity of the retina, i.e. on its being affected by the most feeble impulses. But the tenderness of structure that made the membrane so sensitive also made it liable to being harmed by the access of stronger degrees of light. So the contractile range of the pupil is increased in these animals, so that at all times the only portions of light that are admitted are ones that can be received without injury to the sense. And this power of diminishing the admitted light in every degree includes the power to close the aperture entirely.

There appears to be also in the shape of the pupil of the eye an appropriate relation to the wants of different animals . In horses, oxen, goats, sheep, the pupil of the eye is elliptical, the transverse axis being horizontal. By this structure, although the eye is placed on the side of the head, the elongation of the front of the pupil catches rays coming from objects immediately in front of the animal's face.

13. Peculiar organisations

I believe that all the examples I shall collect under this heading could, consistently enough with technical language, have been classified as 'Comparative Anatomy'. But the way that phrase has come to be used seems to me to be improper: it is rather absurd to speak of *comparative* anatomy when there is nothing to compare—where one animal has a conformation that has nothing corresponding to it in another. The examples I shall present in the present chapter are like that. You will see that they must necessarily be of an unconnected and miscellaneous nature (though some of them are among the strongest supports for my over-all argument.) To dispose them, however, into some sort of order, we will notice, first, particularities of structure which belong to •quadrupeds, birds, and fish as such, or to •many of the kinds included in these classes of animals, and then to •such particularities as are confined to one or two species. [That last sentence is taken verbatim from the original.]

Features of quadrupeds, birds, and fish as such

(1) Along each side of the neck of large quadrupeds runs a stiff, robust cartilage, braced from the head to the middle of the back. Its office is to help support the weight of the head. It is a mechanical provision, of which this is the undisputed use; and it is sufficient (and not more than sufficient) for its purpose. The head of an ox or a horse is heavy, acting at the end of a long lever (consequently with a great purchase) in a direction nearly perpendicular to the joints of the supporting neck. The bones of the neck would be in constant danger of dislocation if they were not fortified by the cartilage I am speaking of. No such organ is found in the human subject, because there the weight of the head acts nearly in the direction of the spine, so that the junction of the vertebrae appears to be sufficiently secure without it. So this cautionary expedient is limited to quadrupeds: the Creator's care is seen where it is wanted.

(2) The oil that birds prune their feathers with, and the organ that supplies it, is provided specifically for the winged creation. On each side of the rump of birds there is a small nipple, yielding on pressure a butter-like substance which the bird extracts by pinching the nipple with its bill. The bird dresses its coat with this oil or ointment, repeating the action as often as its own sensations teach it that it is in any part wanted. The gland, the nipple, the nature and quality of the excreted substance, the manner of obtaining it from its storage in the body, the application of it when obtained, collectively form an evidence of *intention* that it is not easy to withstand. Nothing like it is found in unfeathered animals. What blind drive of nature would produce it in birds and not produce it in beasts?

(3) The air-bladder of a fish provides a plain and direct example of contrivance, and indeed strictly of mechanical contrivance. The principle of the contrivance is clear, and so is the application of the principle. The use of the organ to sustain and to elevate the body of the fish in the water is proved by observing that when the bladder is burst, the fish grovels at the bottom; and also, that flounders, soles, skates, that do not have the air-bladder, seldom rise in the water and do so only with effort. It is easy to see how the purpose is attained, and the suitableness of the means to the end. The rising and sinking of a fish in water, so far as it is independent of the stroke of the fins and tail, can only be regulated by the body's specific gravity. When the bladder in the body of the fish is contracted—which the fish probably has a muscular power of doing—the bulk of the fish is contracted along with it; so the specific gravity is increased and the fish descends; and a reversal of this processes brings it up. A diving machine might be made to ascend and descend on the same principle, by inserting into it an air-vessel that could change the bulk of the machine by its contracting or expanding, thus making the machine specifically heavier or specifically lighter than the water around it. Suppose someone did this, and sought to get a patent for his invention. The patent inspectors, whatever they thought regarding the value of the contrivance, could not possibly entertain a question in their minds whether it *was* a contrivance. No reason has ever been assigned—no reason *can* be assigned—why the conclusion is not as certain in the fish as it is in the machine, why the argument is not as firm in one case as the other.

It would be interesting to learn *how* an animal that lives constantly in water can supply a repository of air. Its way of doing this, whatever it be, is a part, and perhaps the most curious part, of the provision. Nothing like the air-bladder is found in land-animals; and a life in the water has no natural tendency to produce a bag of air. Nothing can be further from an acquired organisation than this is.

Features of many kinds included in these classes

(1) The fang of a viper is a clear and curious example of mechanical contrivance. It is a perforated tooth, loose at the root; in its quiet state it lies flat on the jaw, but it is provided with a muscle which, with a jerk, suddenly erects it. Under the tooth, close to its root and communicating with the perforation, lies a small bag containing the venom. When the fang is raised, the closing of the jaw presses its root against that bag, and the force of this compression shoots the venom out through the tube in the middle of the tooth. What more straightforward or effective apparatus could be devised for inflicting the wound while also injecting the poison? Though lodged in the mouth, it is so constituted that in its quiescent state it does not interfere with the animal's receiving food.

(2) The pouch of the opossum (and of several other species) is a strictly mechanical contrivance. Its simplicity makes the contrivance more obvious than many others, and by no means less certain. A false skin under the animal's belly forms a pouch into which the young litter are received at their birth; where they have easy and constant access to the teats; in which they are transported by the mother from place to place; where they are at liberty to run in and out; and where they find a refuge from surprise and danger. It is their cradle, their asylum, and the machine for their conveyance. The pouch is not a mere doubling of the skin; it is a new organ, provided with bones and muscles of its own—bones to anchor and support the muscles, which serve to open and close the pouch doing this so exactly that in the living animal the opening can hardly be seen except when the sides are forcibly drawn asunder. Is there any action in this part of the animal, any process arising from that action, by which these members could be formed? Can the whole formation be explained in any way except as arising from design?

(3) The middle claw of the heron and cormorant is toothed and notched like a saw. These birds are great fishers, and these notches help them to hold their slippery prey. The use is evident; but the structure cannot be accounted for by the effort of the animal or the exercise of the part. Some other fishing birds have these notches in their bills, for the same purpose; and here again the structure cannot arise from the manner of employing the part. The smooth surfaces and soft flesh of fish were less likely to notch the bills of birds than the hard bodies on which many other species feed.

Features confined to one or two species

(1) The stomach of the camel is well known to retain large quantities of water, and to hold it unchanged for a considerable length of time. This qualifies it for living in the desert. Let us see what the internal organisation is that this rare and beneficial faculty depends on. A number of distinct sacs or bags (in a dromedary thirty of these have been counted) lie between the membranes of the second stomach, and open into the stomach near the top by small square apertures. After the stomach is full, the annexed bags are filled from it through these apertures: and the water so deposited is

- not liable to pass into the intestines,
- kept separate from the solid food, and
- out of the reach of the digestive action of the stomach.

It appears pretty certain that the animal, by the conformation of its muscles, has the power to squeeze this water back from the adjacent bags into the stomach whenever thirst stimulates it to put this power in action.

(2) The tongue of the woodpecker is one of those singularities that nature presents us with when a singular purpose has to be met. The woodpecker lives chiefly on insects lodged in the bodies of decayed or decaying trees. For the purpose of boring into the wood it is provided with a bill that is straight, hard, angular, and sharp. When it has reached the cells of the insects by means of this piercer, its tongue comes into play. This tongue is

- •so long that the bird can dart it out three or four inches from the bill, very unlike every other species of bird;
- •tipped with a stiff, sharp, bony thorn, which is dentated on both sides, like the beard of an arrow or the barb of a hook (which appears to me the most remarkable property of all).

The bird, having exposed the retreats of the insects by the assistance of its bill, with an inconceivably quick motion launches this long tongue out at them, transfixes them on the barbed needle at the end of it, and draws them into its mouth. If this is not mechanism, what is? You might say that by continual endeavours to shoot out the tongue to the limit, the woodpecker's species has gradually lengthened it beyond that of other birds; but how did the tongue get its barb, its dentation? These barbs seem to me to be decisive proofs of mechanical contrivance.

(3) I shall add one more example, for the sake of its novelty. It is always an agreeable discovery when, having noticed an extraordinary structure in an animal, we eventually find out an unexpected use for it. Here is an example of that. The babyrouessa, or Indian hog, a species of wild boar found in the East Indies, has two bent teeth, more than half a yard long, growing upwards, and (which is the singularity) from the *upper* jaw. These instruments are not wanted for offence, which is provided for by two tusks that issue from the lower jaw and resembling those of the common boar; nor does the animal use them for defence. So they might seem to be a superfluity and an encumbrance. But observe the events!—the animal sleeps standing, and in order to support its head it hooks its upper tusks on the branches of trees.

14. Prospective contrivances

I can hardly imagine a more distinguishing mark of design, and thus a more certain proof of it, than *preparation*, i.e. the provision in advance of things that are not to be used until much later; for this implies a contemplation of the future, which belongs only to intelligence.

The bodies of animals provide various examples of such prospective contrivances. ·I shall describe four of them·.

(1) Human teeth provide an example not only of prospective contrivance but of the completion of the contrivance being designedly suspended. The teeth are formed within the gums, and there they stop: their further advance to maturity would be worse than useless to the new-born animal, because the act of sucking by which it is for some time to be nourished will be easier for the nurse and the infant if the inside of the mouth and edges of the gums are smooth and soft than if they are set with hard pointed bones. By the time the teeth are wanted, they are ready. They have been lodged within the gums for some months past, but detained in their sockets for as long as their further protrusion would interfere with the mouth's office [see Glossary]. Nature—i.e. the intelligence that was employed in creation—looked beyond the first year of the infant's life; but while providing for functions that would become necessary after that, it was careful not to inconvenience those that preceded them.

And the prospective contrivance looks still further: beneath the first crop of teeth a second tier is formed from the beginning, though they do not come into use till several years later. This double provision solves a difficulty in the mechanism of the mouth that would have appeared almost unsurmountable. The expansion of the jaw (resulting from the proportional growth of the animal and of its skull) necessarily separates the teeth of the first set to a distance from one another that would be very inconvenient. So when the jaw has attained a great part of its dimensions, a new set of teeth springs up (loosening and pushing out the old ones before them), more exactly fitted to the space which they are to occupy.

(2) It is hard to conceive a more obviously prospective contrivance than the one that is found, in all viviparous animals, in the milk of the female parent. At the moment the young animal enters the world, there is its maintenance ready for it. The particulars to be noted in this economy are neither few nor slight:

(i) the nutritious quality of the fluid, unlike every other excretion of the body;
(ii) the organ for its reception and retention;
(iii) the excretory duct annexed to that organ; and
(iv) the milk's being sent to the breast at the exact time when it is about to be wanted.

We have all these properties in the subject before us, and they are all indications of design. The **(i)** nutritiousness of the fluid is not imitated elsewhere in nature, neither cookery nor chemistry having been able to make milk out of grass. And **(iv)** is the strongest evidence of design. If I had tried to guess beforehand, I would have conjectured that at the time when there was an extraordinary demand for nourishment in one part of the system, there would be the least likelihood of a redundancy to supply another part. The advanced pregnancy of the female has no intelligible tendency to fill the breasts with milk. The lacteal system is a constant wonder; and it adds to other causes of our admiration that the number of the teats in each species bears a proportion to the number of the young. The simplest explanation of this is that it comes from a designing Creator.

(3) The eye is of no use at the time when it is formed. It is an optical instrument made in a dungeon; constructed for the refraction of light to a focus, and perfect for its purpose, before a ray of light has access to it; geometrically adapted to the properties and action of an element with which it has no communication. It is indeed going to enter into that communication, and this is exactly the thing that evidences *intention*. It is 'providing for the future' in the strictest sense of that phrase: it is providing

- not for the then-existing condition of the animal, and
- not for any gradual progress or advance in that same condition, but
- but for a *new* state, the consequence of a great and sudden alteration that the animal is to undergo at its birth.

Is it to be believed that the eye was formed without a view to this change? without a prospect of that condition in which its currently useless fabric is about to be of the greatest use? without a consideration of the qualities of the (hitherto entirely excluded) element with which it would later have such an intimate a relation? A young man makes a pair of spectacles for himself for when he grows old, having no use for them at the time he makes them. Could this be done without knowing and considering the defect of vision to which advanced age is subject? The precise suitableness

- of the instrument to its purpose,
- of the remedy to the defect,
- of the convex lens to the flattened eye

—wouldn't all this show for certain that the future vision troubles had been considered beforehand, speculated on, provided for? all of which are exclusively the acts of a reasoning mind. The eye formed in one state for use only in a different state provides a proof no less clear of being aimed at a future purpose; and a proof proportionally stronger as the machinery is more complicated and the adaptation more exact.

(4) What I have said of the eye holds equally true of the lungs. Composed of air-vessels where there is no air, and elaborately constructed for admitting and expelling an elastic fluid where no such fluid exists, this great organ (with the whole apparatus belonging to it) lies collapsed in the fetal thorax, yet all ready for action the moment its service is needed. This involves having a machine stored for future use, which incontestably proves that it was *expected* that such a use might occur; and *expectation* is the proper act of intelligence. Considering the state of an animal before its birth, I would expect nothing less in its body than a system of lungs. It is like finding a pair of bellows at the bottom of the sea—useless in the situation they are found in, formed for an action that could not possibly be performed, and having no relation or fitness to the element that surrounds them but only to another element in another place.

[He adds details about the openings in the fetus's heart that enable to blood to circulate before there are functioning lungs for it to go through, openings that close after the fetus is born. Paley concludes:] If this is not contrivance, what is?

Given that the action of the air on the blood in the lungs appears to be necessary to the life and health of the animal, how does the fetus live, grow and thrive without it? The answer is that the blood of the fetus is the mother's; that one pair of lungs serves for both.

15. Animate-to-animate relations

When an effect is produced by the joint action of different instruments, the fitness of such instruments to one another for the purpose of producing the effect, is what I call *relation*; and wherever this is observed in the works of nature or of man, it appears to me to bring decisive evidence of understanding, intention, art. In examining the various parts of a watch—the spring, the barrel, the chain, the fusee, the balance, the wheels of various sizes, forms, and positions—what would most strongly strike an observer as evidence of thought, deliberation, contrivance? It is the suitableness of these parts to one another, in •the order in which they act and •the effect they jointly produce. [Paley describes in great detail the physical features of the watch's parts that are explained by their intended collaboration.] What thus struck his attention in the various parts of the watch he could plausibly give the general name 'relation'; and, observing that such relations were found in things produced by art and design and in no other things, he would rightly regard them as characteristic of such productions. (I am speaking of things whose origin and formation could be ascertained by evidence.)

Now, animal economy is full of these relations—it is made up of them.

(1) There are, first, the parts and powers of animals that successively act on their food. Compare this action with the process of a factory. In men and quadrupeds, the food is

- **(i)** broken and bruised by mechanical instruments of mastication, namely sharp spikes or hard knobs, rubbing on one another;
- **(ii)** carried by a pipe into the stomach, where it undergoes the chemical action we call 'digestion';
- **(iii)** delivered, through an orifice that opens and shuts as needed, into the first intestine where it is further dissolved; and then
- **(iv)** the part of the chyle needed for animal nourishment is strained off through tiny tubes opening into the cavity of the intestines; after which
- **(v)** the strained, percolated fluid is carried into the blood-stream which conveys it to every part of the body.

Now I say again, compare this with the process of a factory, with the making of cider, for example, where the apples are

(i) bruised in the mill, then

(ii) fermented in the vat, after which the liquor is

(iii) put into in the hogsheads,

(iv) drawn off into bottles, and then

(v) poured out into glasses to be consumed.

Let anyone show me any difference between these two cases in regard to *contrivance*. The 'relation' of the parts successively employed (our present topic) is no clearer in the second case than in the first. [He goes through them in detail.] The character of the machinery is in both cases this, that one part answers to another part, and every part to the final result.

This parallel might be carried into further detail. Spallanzani has reported a point in which the stomachs of poultry and game birds resemble the structure of corn-mills. For purposes of this comparison, the two sides of the gizzard do the work of the millstones, and the craw corresponds to the hopper. When our fowls are abundantly supplied with food, they soon fill their craw; but it does not immediately pass on into the gizzard, but always enters in very small quantities, in proportion to the progress of grinding. In the same way, in a mill a receiver is fixed above the two large stones that grind the corn; and although the corn is put into the receiver in bushels it allows the grain to dribble only in small quantities into the central hole in the upper millstone.

But we have not done with the alimentary history. There is a general relation between the external organs by which animal it procures its food and the internal powers by which it digests it. [He gives details.]

(2) The relation of the kidneys to the bladder, and of the ureters to both—i.e. of the secreting organ to the vessel receiving the secreted liquor, and of both to the pipe laid between them to convey it from one to the other—is as obvious as the relations among the different vessels employed in a distillery and the pipes between them. Because in this case the animal structure is simple and the parts easily separated, it is an example of correlation that can be presented by dissection to every eye. This correlation of instruments to one another fixes *intention* somewhere.

Especially when the conformation rules out every other solution. If the bladder had been merely an expansion of the ureter, produced by retention of the fluid, there ought to have been a bladder for each ureter. One receptacle, fed by two pipes issuing from different sides of the body yet both conveying the same fluid is not to be accounted for by any such supposition as this.

(3) Relation of parts to one another accompanies us throughout the whole animal economy. Can any relation be more simple or more convincing than the fact that the eyes are so placed as to look in the direction in which the legs move and the hands work? It might have happened very differently if it had been left to chance. Any considerable alteration in the position of the eye or the shape of the joints would have disturbed the line and destroyed the alliance between the sense and the limbs.

(4) But *relation* is perhaps never more striking than when it holds between different things rather than between different parts of the same thing. The relation between a lock and a key is more obvious than the relation between different parts of the lock. A bow was designed for an arrow, and an arrow for a bow; and their being separate implements makes the design more evident.

Nor do the works of the Deity lack this clearest species of relation. The sexes are manifestly made for each other. They form the grand relation of animated nature:

- •universal,
- •organic,
- •mechanical,
- •subsisting in different individuals, like the clearest relations of ·human· art,
- •unequivocal, and
- •inexplicable without design.

So much so that if every other proof of contrivance in nature was dubious or obscure, this alone would be sufficient. The example is complete. Nothing is lacking for the argument. I see no way whatever of getting over it.

(5) The teats of animals that give suck have a relation to the mouth of the suckling progeny, particularly to the lips and tongue. This is another case of correspondence between parts of different individuals.

These are relations of parts that are found in all animals or in large classes of animals. I now describe some examples of the same kind of thing in certain species of animals.

In the swan,

- •the web-foot,
- •the spoonbill,
- •the long neck,
- •the thick down, and
- •the graminivorous stomach

all have a relation to one another, in that they all fit into the single design of meeting the needs of an aquatic fowl floating on the surface of shallow pools of water and seeking its food at the bottom. Start with any one of these structural details and observe how the rest follow it. The web-foot qualifies the bird for swimming; the spoon-bill enables it to graze; but for that it needs a long neck. [And so on.] Or start with some other distinctive part of the swan's body, such as the long neck. Without the web-foot, the long neck would have been an encumbrance to the bird; yet there is no necessary connection between a long neck and a web-foot. In fact they do not usually go together. So how does it happen that they meet only when a particular design demands the aid of both?

This mutual relation, arising from a subservience [see Glossary] to a common purpose, is very observable also in the parts of a mole. The strong short legs of that animal, the palmated feet armed with sharp nails, the pig-like nose, the teeth, the velvet coat, the small external ear, the sensitive smell, the sunk, protected eye, all serve the utilities or the safety of its underground life. [Paley spells this out in considerable detail, including this charming bit:] The plush covering, which by the smoothness, closeness, and polish of its short piles rejects the adhesion of almost every species of earth, defends the animal from cold and wet, and from the impediment it would experience if the mould stuck to its body. From soils of all kinds the little pioneer [here = 'excavator'] comes forth bright and clean. Inhabiting dirt, it is the neatest of all animals.

16. Relations: compensation

Compensation is what we have when the defects of one part or organ are made up for by the structure of another part or organ. Here are some examples.

(1) The short unbending neck of the elephant is compensated by the length and flexibility of its trunk. He could not have reached the ground without it; and if you suggest that he could have fed on the fruit, leaves, or branches of trees, how was he to drink? Why is the elephant's neck so short? Perhaps because the weight of such a heavy head could not have been supported at the end of a longer lever. Thus, to a form that is in some ways necessary but in others inadequate to the animal's needs, a supplement is added which exactly makes up the deficiency under which he laboured.

A general hypothesis by which some people have recently tried to explain the forms of organisms would imply that this trunk was produced, over many generations, by the elephant's constant attempt to thrust out his nose. To anyone who accepts this, I ask: How was the animal to survive during the process, until this prolongation of its snout was completed? What was to become of the *individual* while the *species* was perfecting?

My present concern is simply to point out how this organ relates to the animal's shape: the necessity of the elephant's trunk arises from the shortness of his neck; the shortness of the neck is made necessary by the weight of the head. If we examine the structure of the trunk itself, we'll see one of the most curious of all examples of animal mechanism, namely the lay-out of the ringlets and fibres for the purpose of

- forming a long cartilaginous pipe,
- contracting and lengthening that pipe, and
- turning it in every direction at the will of the animal;

with the addition at the end of a fleshy production, like a finger and performing the office of a finger, so as to pick up a straw from the ground. These properties of a single organ constitute a prime example not only of design but of consummate art and of elaborate preparation in accomplishing that design.

(2) The hook in the wing of a bat is a strictly mechanical compensating contrivance. At the angle of its wing there is a bent claw by which the bat attaches itself to the sides of rocks, caves, and buildings. It hooks itself by this claw, remains suspended by this hold, and takes its flight from this position—operations that compensate for the decrepitude of its legs and feet. Without the hook, the bat would be the most helpless of all animals, unable to run on its feet or raise itself from the ground. In placing a claw on that part, the Creator departed from the usual pattern of winged animals. A singular defect required a singular substitute.

(3) Birds of the crane kind are to live and seek their food among the waters; but, having no web-feet, they cannot swim. To make up for this deficiency they are provided with long legs for wading, or long bills for groping, or both. This is compensation. Notice how every part of nature is occupied by appropriate inhabitants. Not only is the surface of deep waters peopled by numerous tribes of birds that swim, but marshes and shallow pools have almost as many tribes of birds that wade.

(4) In the structure of the common parrot's beak there is an inconvenience and a compensation for it. The inconvenience involves a dilemma that frequently occurs in the works of nature, namely that the peculiarity of structure that makes an organ fit for one purpose necessarily unfits it for some other purpose. The upper bill of the parrot is so much hooked, and so much overlaps the lower, that if (as in other birds) only the lower bill could move, the bird could scarcely gape wide enough to receive its food; yet this hook and overlapping of the bill could not be spared, for they form the instrument by which the bird climbs, and also breaks the nuts and other hard substances it feeds on. Nature has dealt with this problem by making the upper bill movable, as well as the lower. In most birds the upper bill is rigidly connected to the skull; but in the parrot it is joined to the skull by a strong membrane on each side of it, which raises and lowers it at pleasure.

(5) The spider's web is a compensating contrivance. The spider lives on flies, without wings to pursue them; a case (one would have thought) of great difficulty, yet provided for by a resource that no plan or effort of the spider could have produced if its external and internal structure had not been specifically adapted to the operation.

(6) In many species of insects the eye is fixed, and consequently with no power to turn the pupil towards the object. This great defect is perfectly compensated by a mechanism that we would not have suspected. The eye is a multiplying glass, with lenses looking in every direction and catching every object. Thus, although the orb of the eye is stationary, the field of vision is as wide as that of other animals. When this lattice-work was first observed, the number and smallness of the surfaces must have added to the surprise of the discovery. Adams tells us that 1400 of these little lenses have been counted in the two eyes of a drone-bee.

In other cases the compensation is achieved by the number and position of the eyes themselves. The spider has eight eyes, mounted on different parts of the head. They do not move, but by their situation they take in every view that the wants or safety of the animal make it necessary for it to take.

[Certain features of the **(7)** eye of the chameleon compensate for its inflexible neck; and a structural feature of the **(8)** intestine of the amphibious sea-fox compensates for the intestine's brevity.]

(9) The works of the Deity are known by expedients. Where we would look for absolute destitution—where we can find nothing but wants—some contrivance always comes in to make up for the privation. •A snail without wings, feet, or thread climbs the stalks of plants by the sole aid of a sticky liquid discharged from its skin. •A mussel, which might seem to lie helplessly at the mercy of every wave that went over it, has the singular power of spinning strong tendon-like threads by which it moors itself to rocks and timbers. •Whereas a cockle uses its stiff tongue to make for itself a shelter in the sand. •A lobster has in its constitution a difficulty so great that one could hardly guess how nature would deal with it. Because of the hardness of its shell, it cannot grow with the lobster (like the skins of most animals); and because the shell encases the lobster's limbs as well as its trunk, it cannot be enlarged by growth along its edge (like the shells of bivalves). How then was the growth of the lobster to be provided for? If a change of shell became necessary, how was the lobster to extricate himself from his present confinement? how was he to uncase his buckler or draw his legs out of his boots? At certain seasons the shell of the lobster grows soft, the animal swells its body, the seams open, and the claws burst at the joints. When the shell has thus become loose on the body, the lobster by a spasmodic motion casts it off. In this state, the liberated but defenceless fish retires into holes in the rock. The released body now suddenly pushes its growth, and in about 48 hours a new shell, is formed, adapted in every part to the increased dimensions of the animal. This wonderful change is repeated every year.

There are also compensations that extend over large classes of organisms, and to large portions of living nature.

(a) In quadrupeds, the deficiency of teeth is usually compensated by the faculty [see Glossary] of rumination. The tribe of sheep, deer and ox are without fore-teeth in the upper jaw; and they ruminate. The horse and ass are provided with teeth in the upper jaw, and do not ruminate. In the former class, the grass and hay descend into the stomach in almost the state in which they are cropped from the pasture. In the stomach they are softened by the gastric juice, which in these animals is unusually copious. Thus softened and tenderised, they are returned to the mouth, where the grinding teeth complete at their leisure the breakup that is necessary but was before left imperfect. The gastric fluid of sheep, for example, has no effect in digesting plants unless they have previously been chewed; but once vegetables are reduced to pieces by chewing, the fluid then exerts on them its specific operation.

(b) In birds the compensation is still more striking. They have no teeth at all. What have they then to make up for this severe lack? (I am speaking of turkeys, ducks, geese, pigeons and their like—grain-eating and plant-eating birds—for it is only concerning these that the question arises.) They are provided with a special and most powerful muscle, called the 'gizzard', whose inner coat is equipped with rough folds which by a strong friction against one another break and grind the hard food, as effectively as a coffee-mill would do, and by the same mechanical action. The gastric juice of these birds will not operate on the unbroken grain; so without the grinding action of the gizzard a chicken would starve on a heap of corn. A gizzard is not found in birds of prey; their food does not need to be ground down. The compensatory contrivance goes no further than the necessity.

(c) A very numerous and comprehensive tribe of terrestrial animals are entirely without feet; yet they move about, and do so quite swiftly. The lack of feet is compensated by the disposition of the muscles and fibres of the trunk. By means of the joint action of longitudinal and annular fibres—i.e. of strings and rings—the body of a reptile can be alternately shortened and lengthened, pulled in and stretched out. The result of this action is a progressive (and in some cases rapid) movement of the whole body in whatever direction the will of the animal sends it. The meanest creature is a collection of wonders. [He cites the mechanism by which an earthworm moves.] If we had never seen an animal move on the ground without feet, and we were set this problem:

> Given that an animal is capable of alternate contraction and relaxation, describe how it might be constructed so as to be able to move on the ground without feet;

something like the organisation of reptiles might have been hit on by the ingenuity of an artist; or it might have been exhibited in an automaton by the combination of springs, spiral wires, and ringlets. But surely the solution of the problem would be granted the praise of invention and of successful thought; there could be no doubt that intelligence had been employed in finding it.

17. Animate-to-inanimate relations

I have considered how the parts of an animal relate to other parts of the same animal, and how an animal relates to another individual of the same species. But we should also consider how the bodies of animals relate to the elements [see Glossary] by which they are surrounded. Some of these relations, grounded in the animals' constitution and properties, are close and important.

(1) Can it be doubted that the wings of birds have a relation to air, and the fins of fish to water? They are instruments of motion, suited to the properties of the medium in which the motion is to be performed; and these properties are different. Wasn't this difference contemplated when the instruments were differently constituted?

(2) The structure of the animal ear depends for its use on the specific nature of the fluid it is surrounded by. Not every fluid would serve. It has to be something whose particles repel one another, so that it forms an *elastic* medium; for it is by the successive pulses of such a medium that the undulations caused by the external body are carried to the organ, creating a communication between the object and the sense. If that is not done, the internal machinery of the ear, subtle though it is, cannot act at all.

(3) The organs of voice and respiration are indebted for the success of their operation—as much as the ear is—to the special qualities of the fluid the animal is immersed in. The structure of our organs and the properties of our atmosphere are made for one another. And it is the same relation whether you regard the organ as made for the element or (a less natural way of considering it) the element as prepared for the organ.

(4) But there is another fluid we have to consider. It has properties of its own, laws of acting and of being acted on totally different from those of air and water. I am talking about light. An organ is adapted, an instrument is correctly adjusted, to this new, this singular element—to qualities all its own and perfectly distinct and remote from the qualities of any other substance we know. The instrument is as much

a stand-out among the parts of the body,
•unique in in its form and in the substance it is composed of, and
•remote from the materials, the model, and the analogy of any other part of the animal frame,

as the element to which it relates is a stand-out among the substances we have dealings with. If this does not prove appropriation, what would prove it?

Yet the element of light and the organ of vision, however related in their office and use, have no connection whatever in their origins. The action of rays of light on the surfaces of animals has no tendency to breed eyes in their heads; and on the other hand the animal eye does not generate or emit light.

(5) Throughout the universe there is a wonderful proportioning of one thing to another. The size of animals (especially human animals) in relation to other animals and to the plants that grow around them is suited to their convenience. A giant or a pygmy could not have milked goats, reaped corn, mowed grass, ridden a horse, trained a vine, or shorn a sheep, or anyway not with the same bodily ease as we do. A pygmy would have been lost among rushes, or carried off by birds of prey.

(6) How close is the suitableness of the earth and sea to their various inhabitants; and of these inhabitants to their appointed places of residence!

Take the earth as it is; and consider the correspondence of the powers of its inhabitants with the properties and condition of the soil they tread. Take the inhabitants as they are; and consider the substances the earth yields for their use. They can scratch its surface, and its surface supplies all they want.

When we pass from land to water, we pass through a great change. But we are accompanied by a *corresponding* change in animal forms and functions, in animal capacities and wants. The earth in its nature is very different from the sea, but one accords with its inhabitants as exactly as the other.

(7) The last relation of this kind that I shall mention is the relation of *sleep* to *night*, which also appears to me to be a relation that was expressly intended. Two points are clear •the animal frame requires sleep, and •night brings with it a silence and cessation of activity that allows sleep to be taken without interruption. Animal existence is made up of action and slumber, and nature has provided a season for each. An animal that did not need rest would always live in daylight. A very active animal that needs to have its strength repaired by sleep has a constitution that fits with the returns of day and night. In the human species, for instance, if the bustle, labour and motion of life were upheld by the constant presence of light, sleep could not be enjoyed without being disturbed by noise and without time being spent on it that the sleeper would prefer to spend furthering his interests.

But night is not made solely (or even principally) for man. Inferior but less perverted natures taste its solace and expect its return with greater exactness and advantage than man does. I have often observed and admired the satisfaction and the regularity with which the greatest part of the irrational world yield to this soft necessity, this grateful vicissitude; how comfortably the birds of the air, for example, address themselves to the repose of the evening, and with what alertness they resume the activity of the day.

Nor does it disturb my argument that certain species of animals are active during the night and at rest in the day. With respect to them too there is a change of condition in the animal and an external change corresponding with it. There is still the relation, though inverted. In fact, the repose of other animals sets these at liberty, inviting them to their food or their sport.

If the relation of sleep to night (and in some instances its converse) is real, it is truly amazing. Day and night are things close to us; the change applies immediately to our sensations; of all the phenomena of nature, it is the most obvious and familiar to our experience; but in its cause it belongs to the great motions that are passing in the heavens. As the earth rotates around its axis, it ministers to the alternate necessities of the animals on its surface while at the same time obeying the influence of those **attractions** that regulate the order of many thousand worlds. The relation of sleep to night is the relation of the inhabitants of the earth •to the rotation of their globe; probably even •to the system that globe is a part of; and indeed •to the congregation of systems of which theirs is only one. If this account is true, it connects a chicken roosting on its perch with the spheres revolving in the firmament.

(8) If you reject the view that a central **attraction** explains the rotation of the earth on which the succession of day and night depends, I refer you to something that certainly does, namely the change of the seasons. Now, the constitution of animals given to torpor [= 'hibernation'] relates to winter in the way that sleep relates to night. As a defence against cold, and against the lack of food that the approach of winter induces, the Preserver of the world has provided migration for many animals and torpor in many others. As one example out of a thousand: if the bat did not sleep through the winter it would starve, as the moths and flying insects on which it feeds disappear. And the transition from summer to winter carries us into the very midst of physical astronomy, i.e. into the laws that govern the solar system at least, and probably all the heavenly bodies.

18. Instincts

I go immediately from relations to instincts, because I see them as a sort of relation. They are related to the animal's organisation because they combine with it to produce a joint effect. In many cases, instincts are strictly relations because they connect one animal with another animal.

An instinct is a propensity ·to act in a certain way· prior to experience and independent of instruction. We think that it is by instinct that the sexes of animals seek each other, that animals cherish their offspring, that the young quadruped is directed to the teat of its mother, that birds build their nests, and brood so patiently on their eggs; that insects which do not sit on their eggs deposit them in places where the young when hatched will find their appropriate food; that the salmon and some other fish go out of the sea into rivers to shed their spawn in fresh water.

The incubation of eggs

Take the incubation of eggs. I am sure that a couple of sparrows hatched in an incubator and kept separate from the rest of their species would proceed as other sparrows do in everything relating to the production and preservation of their brood. If that is right, the thing is inexplicable on any hypothesis except that of an *instinct* impressed on the constitution of the animal. What else could induce the female bird to prepare a nest before she lays her eggs? The fullness she might feel in a particular part of her body, from the growth and solidity of the egg, could not inform her that she was about to produce something which, when produced, was to be preserved and taken care of. Prior to experience, nothing led to this inference or to this suspicion. In every other instance, what issued from the body was rejected.

Again, how are birds to know that their eggs contain their young? Nothing in the appearance or in the internal composition of an egg could lead even the most daring imagination to conjecture that it was going to produce a living, perfect bird from under its shell. [He elaborates this point in great detail; then sums up:] It is hard to strip the mind of its experience. When familiarity has once put surprise to sleep, it is difficult to reawaken it. But if we could forget everything that we know (and that our sparrows never knew) about oviparous generation, divesting ourselves of all information except what we derived from reasoning on the appearances or qualities discovered in the objects presented to us, Harlequin coming out of an egg on the stage would not astonish a child more than the hatching of a chicken would and should astonish a philosopher.

Even supposing the sparrow somehow knew that within that egg the principle [see Glossary] of a future bird was concealed, from what chemist was she to learn that warmth was needed to bring it to maturity, or that the temperature of her own body was the degree of warmth required?

There is another case of oviparous economy that is even less likely to be the effect of education than it is in birds, namely that of moths and butterflies. They deposit their eggs in the precise substance—e.g. a cabbage—that will provide appropriate food not for the butterfly but for the caterpillar that will come from her egg. [He argues that the butterfly could not possibly have empirical evidence that this was the way to behave. The argument is perfectly convincing; but we hardly need it, and it is wearyingly long.]

Parental affection

But even if we could find a plausible origin for all the preparations that many unthinking animals make for their young, we would still have to account for the parental affection that is the source and foundation of these phenomena. This cannot be explained except as a matter of instinct.

For I don't think we shall want to explain the conduct of brutes towards their offspring in terms of •a sense of duty or of decency, •a care for reputation, or •compliance with public manners, with public laws, or with rules of life built on a long experience of their utility! And all attempts to account for the parental affection from association fail. With what is it associated? Most immediately with the throes of parturition, i.e. with pain and terror and disease. The more remote (but not less strong) association that which depends on *analogy*—·i.e. association with events that are somehow like this one·—is all against it. Everything else that comes from the body is cast away and rejected. In birds, is the egg what the hen loves? or is she kept on her nest by the expectation of a future progeny? What cause has she to expect delight from her progeny?

The salmon overcomes many obstacles in her progress up fresh rivers. And when she is there she sheds a spawn and immediately leaves it in order to return to the sea; and this output of her body she never afterwards recognizes in any shape whatever. Where shall we find a motive for her efforts and her perseverance? Shall we seek it in argumentation or in instinct?

When the butterfly lays her eggs in a place where the offspring caterpillar will find appropriate food, how shall we account for her conduct? I do not mean for her art and judgement in selecting and securing a maintenance for her young, but for the impulse on which she acts. What would induce her to exert any art or judgment or choice about the matter? The undisclosed grub, which she is destined not to know, can hardly be the object of a particular affection, if we deny the influence of instinct. So there is nothing left to her but something her nature seems incapable of, an abstract anxiety for the general preservation of the species, a kind of patriotism, a care that the butterfly race not become extinct.

The variety of resources, expedients, and materials that animals of the same species are said to have recourse to under different circumstances does not tell against the doctrine of instincts. What we want to account for is the propensity. Given that the propensity is there, it is probable enough that it will get the animal to act differently according to different exigencies. And this adaptation of resources may look like the effect of art and consideration, rather than of instinct, but still the propensity itself is instinctive. It is said that the woodpecker in Europe deposits her eggs in cavities that she scoops out in the trunks of soft or decayed trees, so that the eggs lie concealed from the eye and the hand of man; whereas in the forests of Guinea and the Brazils, which man seldom frequents, the woodpecker hangs her nest to the twigs of tall trees, thereby placing them out of the reach of monkeys and snakes. Suppose this is true, and is adduced as evidence of a reasoning and distinguishing precaution on the part of the bird that builds these nests, still the question returns: why is there a propensity to build at all?

Explaining instinct by sensation

I know about the theory—I shall call it 'the Hypothesis'—that resolves instinct into sensation, asserting that

> what appears to have a view and relation to the •future is only the result of the •present disposition of the animal's body and of pleasure or pain experienced at the time.

Thus the incubation of eggs is accounted for by the pleasure the bird is supposed to get from the pressure of the smooth convex surface of the shells against the abdomen, or by the relief the egg's mild temperature may provide for the heat of the lower part of the body (which is observed to be greater than usual at this time). This present gratification is the only thing that keeps the hen sitting on her nest, and so far as she is concerned the hatching of the chickens is an accidental consequence. Similarly, the affection of viviparous animals for their young is explained by the relief—perhaps even the pleasure—they get from giving suck. The young animal's seeking its mother's teat is explained by its sense of smell, which is attracted by the odour of milk. The salmon's forcing its way up the stream of fresh-water rivers is attributed to some gratification or refreshment she receives from the change of element in this particular state of her body.

Two main things should be said about the Hypothesis.

(i) Of the cases requiring solution, there are few it can be applied to with tolerable probability, and none it can be applied to without strong objections based on the circumstances of the case. The cow's attention to its calf and the ewe's to its lamb seem to be prior to their sucking. The attraction of the calf or lamb to the mother's teat is not explained by simply referring it to the sense of smell. What made the scent of milk so agreeable to the lamb that it follows with its nose or seeks with its mouth the place it comes from? No observation, experience or argument could *teach* the newborn animal that the source of the scent was food. And none of the animals that are not designed for that nourishment ever try to suck or to seek out any such food. We can only conclude that the parts of animals related to suckling are fitted for their use, and constructed with knowledge of that use.

(ii) Even in the cases where the Hypothesis looks strongest, it does not *at all* weaken the argument for intention and design. The doctrine of instincts is that of appetencies [see Glossary] added to an animal's constitution to achieve a purpose beneficial to the species. The Hypothesis derives these appetencies from organisation; but then this organisation is just as specifically, precisely, and therefore evidently adapted to the same ends as the appetencies ·or instincts· themselves would be according to the old way of looking at things. According to the Hypothesis, sensation takes the place of foresight, but this ·sensation· is the effect of contrivance on the part of the Creator. Suppose that the hen *is* induced to brood on her eggs by the enjoyment she experiences from the pressure of round smooth surfaces or the application of a temperate warmth. How does it come about that this itching or whatever that is supposed to cause the bird's inclination is felt at exactly the time when the inclination itself is needed, when it tallies so exactly with the internal constitution of the egg and with the help that constitution requires in order to bring the egg to maturity? In my opinion, if we accepted this solution it should *increase* our admiration of the contrivance. A gardener lighting up his stoves exactly when he wants to force his fruit, and when his trees require the heat, does not give a more certain evidence of design.

Again, when a male and female sparrow come together, they do not meet to confer on the expediency of perpetuating their species. As an abstract proposition, they don't care a whit whether their species is perpetuated! They follow their sensations; and this results in all the consequences that the wisest counsels could have dictated, that could have been produced by the most solicitous care for futurity, the most anxious concern for the sparrow-world. But how do these consequences ensue?

- The sensations and the constitution they depend on are as plainly directed to the purpose we see fulfilled by them,
- the series of intermediate effects are as manifestly planned with a view to that purpose, i.e.
- *design* is as completely displayed by the phenomena,

as would be the case if the operations were begun or carried on by what some ·of us· regard as the only things properly called 'instincts', namely desires directed to a future end and having no accomplishment or gratification distinct from the attainment of that end.

In short, I say to the patrons of the Hypothesis: So be it, that the actions of animals that we refer to instinct are not performed with any view to their consequences, but are attended in the animal with a present gratification and are pursued for the sake of that gratification alone; what does all this prove but that the foresight, which must be somewhere, is not in the animal but in the Creator?

[Paley adds a paragraph about the intensity of parental affection in animals, and about how much this sometimes costs the parents, especially the mothers.]

One observation more, and I will dismiss the subject. The pairing of birds, and the non-pairing of beasts, forms a distinction between the two classes, which shows that the conjugal instinct is varied according to the needs of the offspring. In quadrupeds, the young animal draws its nourishment from the body of the mother. The male parent does not—*cannot*—contribute anything to its maintenance. In the winged race, the young bird is nourished by food that requires the industry [see Glossary] of both parents to procure and bring it home in a large enough quantity for the demands of a numerous brood. In this difference we see a reason for the vagrant instinct of the quadruped, and for the faithful love of the feathered mate.

19. Insects

[In this chapter Paley 'collects into a chapter by themselves' some examples of contrivance in insects that he 'could not properly introduce under any of the headings' of previous chapters; and inserts a diversion concerning animals with shells. This 'collection' of hard-to-classify material is omitted from the present version.]

20. Plants

I think a designed and studied mechanism to be, in general, more evident in animals than in plants; and there is no need to dwell on a weaker argument where a stronger is at hand. But a few observations on the vegetable kingdom lie so directly in my path that it would be improper to pass by them without notice. [At the risk of 'impropriety', the present version omits this 'weaker argument'.]

21. The elements

When we come to the elements [see Glossary] we take leave of mechanics, because we come to things of whose organisation (if indeed they are organised) we are admittedly ignorant; in fact, our investigations reach a dead-end long before we arrive at the elements. But then it is for our comfort to find that a knowledge of their constitution is not necessary for us. For instance, as Addison has well observed,

> 'We know water sufficiently when we know how to boil, how to freeze, how to evaporate, how to make it fresh, how to make it run or spout out in whatever quantity and direction we please, without knowing what water is.'

This observation is even more proper now than it was when it was made; for the constitution and constituent parts of water seem in some measure to have been recently discovered, yet apparently we can make no better or greater use of water since the discovery than we did before it.

We can never think of the elements without reflecting on how many uses one substance can have. The **air** supplies the lungs, supports fire, conveys sound, reflects light, diffuses smells, gives rain, wafts ships, bears up birds. **Water**, besides maintaining its own inhabitants, is the universal nourisher of plants, and through them of terrestrial animals; is the basis of their juices and fluids; dilutes their food; quenches their thirst, floats their burdens. **Fire** warms, dissolves and illuminates, and is the great promoter of vegetation and life, if not necessary to the support of both.

I could go on almost as long as I pleased on each of these uses, but it seems to me that I hardly need to do more than state them. But here are a few remarks that I judge it necessary to add.

(1) Air is essentially different from earth. There appears to be no necessity for an atmosphere's investing our globe; yet it does invest it, and we see how many, various, and important are the purposes it serves for every order of animated beings on the terrestrial surface.

If I could see only by means of rays coming directly from the sun, whenever I turned my back on the sun I would find myself in darkness. If I could see by reflected light, but only light reflected from solid masses, these masses would shine and glisten, but it would be in the dark. What enables the world to be illuminated in the way it *is* is the light of the sun coming to the eye from all sides and in every direction, reflected by the numerous, thickly scattered, widely diffused particles of the air.

That function of the air needed a little explaining. Each of its other uses will be understood on the first mention of it.

The atmosphere has the power to evaporate fluids, and the adjustment of this power to our needs is seen in its action on the sea. Water and salt are intimately mixed together in the sea, yet the atmosphere raises the water and leaves the salt. Pure and fresh raindrops have been collected from brine!

By evaporation water is carried up into the air; by the reverse process it falls down on the earth. And how does it fall? Not by the clouds being all at once re-converted into water, and descending like a sheet; not by rushing down in columns from a spout; but in moderate drops, as from a colander.

Air is made unfit for the support of animal life by respiration, flame and putrefaction. By the constant operation of these corrupting principles, the whole atmosphere would eventually come to be deprived of its needed degree of purity, if there were no restoring causes. Some of these causes seem to have been discovered. •Vegetation proves to be one of them: a sprig of mint, corked up with a small portion of foul air placed in the light, makes it again capable of supporting life or flame. So here is a constant circulation of benefits between the two great provinces of organised nature: the plant purifies what the animal has poisoned; in return, the contaminated air is more than ordinarily nutritious to the plant. •Agitation with water turns out to be another of these restoratives. The foulest air, shaken in a bottle with water for long enough, recovers much of its purity. The waves in a storm at sea are doing the very thing that was done in the bottle. So it ought to reconcile us to these agitations of the elements whose consequences we sometimes deplore, to know that they tend powerfully to restore to the air the purity that so many causes are constantly impairing.

(2) Water is admirable for the negative qualities that constitute its purity. [He recites some of the drawbacks if water as such had a taste, summing up:] Having no taste of its own, it becomes the sincere vehicle of every other liquid.

Equally admirable is the constant round that water travels, by which—without spoiling or wastage—it continually offers itself to the wants of the habitable globe. From the sea are exhaled the vapours that form the clouds; these clouds descend in showers that penetrate the crevices of the hills and fill springs; the springs flow in little streams into the valleys where they unite and become rivers, which then feed back into the ocean. So there is an incessant circulation of the same fluid, and probably not one drop more or less now than there was at the creation.

(3) I said above that 'fire dissolves'. This probably gave you only the thought of fire melting metals, resins, and some other substances, fluxing ores, running glass, and helping us in many of our chemical or culinary operations. But these are only intermittent uses, and provide a very imperfect [see Glossary] notion of what fire does for us. The great office of fire in the economy of nature is keeping things in a state of solution, i.e. in a state of fluidity. If it were not for the presence of a certain degree of heat, all fluids would be frozen. The ocean itself would be a quarry of ice; universal nature stiff and dead.

So we see that the elements have a strict relation not only to the constitution of organised bodies but also to each other. Water could not perform its office to the earth without air; nor exist as water without fire.

(4) Whether we regard light as of the same substance as fire or a different substance, its *usefulness* to us is undisputed. The observations I shall offer will concern the little that we seem to know of its constitution.

Light passes from the sun to the earth in eleven minutes,[1] a distance that it would take a cannon ball 25 years to cover. Nothing more need be said to show the velocity of light. Urged by such a velocity, with what force must its particles drive against every substance, animate or inanimate, that stands in its way! This might seem to be a force sufficient to shatter to atoms the hardest bodies, let alone that tenderest of animal substances, the eye.

This is guarded against by a corresponding minuteness of the particles of which light is composed. The human mind cannot imagine anything as small as a particle of light, but this smallness is easy to prove. A drop of tallow expended in the wick of a farthing candle will send forth rays sufficient to *fill* a hemisphere of a mile diameter, so that an aperture the size of the pupil of an eye, wherever it is placed within the hemisphere, will be sure to receive some of them. We cannot estimate what floods of light are continually poured from the sun, but we can compute the immensity of the sphere with the sun at its centre and the orbit of the earth on its perimeter; and we have evidence that throughout this whole region the particles of light lie, in latitude at least, near to one another. The density of the sun's rays at the earth is such that the number falling on a burning-glass of an inch diameter is sufficient, when concentrated, to set wood on fire.

The thinness and the velocity of particles of light, as ascertained by separate observations, may be said to be proportioned to each other; both surpassing our utmost stretch of comprehension, but *proportioned*; and it is just this proportion that converts a fearsome element into a welcome visitor.

22. Astronomy

I have never thought that astronomy is the best medium through which to prove the agency of an intelligent Creator; but once this has been proved, astronomy shows beyond all other sciences the magnificence of the Creator's operations. It raises the already-convinced mind to sublimer views of the Deity than any other subject provides; but it is not as well adapted to the purpose of *argument* as some other subjects are. We have no way to examine the constitution of the heavenly bodies. The very simplicity of their appearance is against them: we see only bright points, luminous circles, or the phases of spheres reflecting the light that falls on them. Now, we deduce design from relation, aptitude, and correspondence of *parts*, so some degree of complexity is necessary for a subject to be fit for this sort of argument. But the heavenly bodies (except perhaps for Saturn's ring) do not present themselves to our observation as compounded of parts at all. This may be a perfection in them, but it is a

[1] [Actually, a little over eight minutes.]

disadvantage to us as inquirers into their nature. They do not come within reach of our mechanics.

And what I say of their forms is true also of their motions. Their motions are carried on without any perceptible intermediate apparatus, which cuts us off from one principal ground of argumentation and analogy. We have nothing to compare them with; no invention, discovery, operation or resource of art that in this respect resembles them. Even things that are made to imitate and represent them—such as planetaria and celestial globes—have no affinity to them in the cause and principle [see Glossary] by which their motions are actuated. I can assign a reason of utility to explain why, though the action of terrestrial bodies on each other is nearly always through the intervention of solid or fluid substances, central attraction does not operate in this manner. The intervals between the planetary orbs had to be devoid of any inert matter, fluid or solid, because such an intervening substance would by its resistance destroy the very motions that attraction is employed to preserve. This may be a final cause of the difference; but still the difference destroys the analogy.

Actually, what is really wonderful is how much understanding of astronomy we *do* have. A diminutive animal on the surface of one of the planets—a little, busy, inquisitive creature—has been able to observe the whole system of worlds to which its own world belongs; and to note the changes of place of the immense globes that compose it, and very precisely mark out beforehand the location in the heavens they will be found to have at any future moment. And it has done this by the use of senses given to it for its domestic necessities, and of telescopes that it has had the skill to produce. All this is wonderful, whether we aim our admiration at the constancy of the heavenly motions themselves or at the perspicacity and precision with which mankind has noticed them. And this is not even the chief part of what astronomy teaches. By bringing acutest reasoning to bear on the exactest observation, the astronomer has been able, out of the confusion (for such it is) under which the motions of the heavenly bodies present themselves to the eye of a mere sky-watcher, to work out their order and their real paths.

So our knowledge of astronomy is admirable, though imperfect [see Glossary]; and among the admitted factors that hamper our investigation of the Deity's wisdom in these the grandest of his works, we find in the phenomena circumstances and laws that are sufficient to indicate an intellectual agency in three of its principal operations—

- *choosing*, out of a boundless variety of equally possible suppositions, the one that is beneficial;
- *determining* that convenience would come from something with a thousand-to-one probability of not being convenient, and
- *regulating* the quantity and degree of things which by their nature were unlimited with respect to both.

I shall offer a few instances under each of these headings, selecting ones that best admit of informal explanation. [You'll see that Paley does not strictly organise the rest of this chapter 'under these headings'.]

(ia) Among proofs of choice, one is the fixing of the source of light and heat in the centre of the ·solar· system. The sun is afire and luminous; the planets that move around it are cold and dark. There seems to be no antecedent necessity for this order. Nothing in the nature of the heavenly bodies requires the stationary ones to be on fire and the moving ones to be cold. So when we consider that the sun is *one* and its planets are at least *seven*, and that it is indifferent to their nature •which are luminous and which are opaque and •what order they are in with respect to each other, we can judge how unlikely it is that the present arrangement took place by chance.

Some of those who reject an intelligent Creator guess that the planets themselves are cooled or cooling masses that were once thousands of times hotter than red hot iron, as the sun is. And they usually contend that the planets are masses of matter that were originally struck off from the body of the sun by the impact of a comet, or by a shock from some other cause that we don't know. If these erstwhile parts of the sun have in process of time lost their heat, the sun itself must also lose its heat in due course and therefore be incapable of an eternal duration in the state in which we see it.

I take it to be obvious that the actual mode of distributing luminous and opaque bodies is preferable to any other. It requires more astronomy than I can lay before you to show in detail what would be the effect on the system of a dark body at the centre and of one of the planets being luminous; but I don't think that diagrams or calculations are required to make it clear that •the ignited planet would not be sufficient to illuminate and warm the rest of the system, and that •its light and heat would be imparted to the other planets much more irregularly than light and heat are now received from the sun. (The former point assumes that the revolving bodies would have to be smaller than the central one.)

(ib) Another thing in which a choice appears to be exercised, and where wrong possible choices infinitely outnumbered right ones, is what geometricians call the axis of rotation. I shall try to explain. The earth is not an exact globe but an oblate spheroid, something like an orange. Now the ·possible· axes of rotation are as many as can be drawn through the centre to opposite points on the surface; but of these axes none are permanent except either •its *one* shortest diameter, i.e. the one that passes through the heart of the orange from the place where the stalk is inserted into it, or •its *many* longest diameters, all at right angles with the shortest one and all ending at the circumference that goes around the thickest part of the orange. The shortest diameter is that on which in fact the earth turns, and it is a permanent axis. If the earth had been set spinning by blind chance, a casual impulse, a random stroke or push, the odds were infinite that it would have been spun on a wrong axis. When a spheroid in rotatory motion gets on a permanent axis, it keeps there, its poles preserving their direction with respect to the plane and to the centre of its orbit. But when it turns on an impermanent axis, it is always liable to vacillate from one axis to another, with a corresponding change in the inclination of its poles. The effect of this unfixedness would be that the equatorial parts of the earth might become the polar, or the polar the equatorial; to the utter destruction of plants and animals, which cannot interchange their situations but are respectively adapted to their own. The habitable earth and its beautiful variety might have been destroyed by a simple mischance in the axis of rotation.

(ic) By virtue of the simplest law that can be imagined, namely that

> a body in motion continues in the line in which it was proceeding, and with the same velocity, unless there is some cause for change,

it comes about that cases arise in which attraction, incessantly drawing a body towards a centre, never brings it to that centre but keeps it in eternal circulation around it. If it were possible to fire off a cannon-ball with a velocity of five miles per second, and the resistance of the air could be taken away, the cannon-ball would for ever wheel round the earth instead of falling down on it. This is the principle that sustains the heavenly motions. The Deity, having appointed this law to matter, has turned it to a wonderful account in constructing planetary systems.

The actuating cause in these systems is an attraction that varies inversely with the square of the distance; that is, at twice the distance it has a quarter of the force; at half the distance it has four times the strength, and so on. Now, concerning this law of variation three things should said.

First , for all we know to the contrary, attraction was just as susceptible of one law as of another. It might have

- been the same at all distances,
- increased as the distance increased,
- diminished with the increase of the distance, but in ·any one of· ten thousand different proportions from the actual one, or
- followed no stated law at all.

If attraction is what many Newtonians thought it to be, a primordial property of matter—not dependent on or traceable to any other material cause—then by the very nature and definition of a primordial property it was indifferent to all laws. If attraction is caused by something immaterial, then again for all we know to the contrary it was indifferent to all laws.

There is an account of attraction that seems to assign to it the law that we find it to observe, making it a law not of choice but of necessity. This account ascribes attraction to an emanation from the attracting body. It is probable that the influence of such an emanation will be proportioned to the density of the rays of which it is composed, and this will vary inversely with the square of the distance. I do not question the mathematics of this solution, but I do question whether there is any sufficient reason to believe that attraction is produced by an emanation. For my part, I am totally at a loss to comprehend how particles streaming *from* a centre should draw a body *towards* it. [He adds further reasons for scepticism about this theory, and concludes:] Except this one point about the variation of the attracting force at different distances agreeing with the variation of the density, there is nothing whatever to support the hypothesis of an emanation and—it seems to me—almost insuperable reasons against it.

Secondly, while the possible laws of variation were infinite, the laws compatible with the preservation of the ·solar· system lie within narrow limits. If the attracting force had varied according to *any* direct ·as against inverse· law of the distance, great destruction and confusion would have ensued. If the large and remote planet Saturn had attracted the earth in proportion to the quantity of matter contained in it (which it does) and also in any proportion to its distance, it would have dragged our globe out of its course and have perplexed its motions to a degree incompatible with our security, our enjoyments, and probably our existence. Of the inverse laws, if the centripetal force had changed as the *cube* of the distance or in any higher proportion, the consequence would have been that once the planets began to approach the sun they would have fallen into it; if they once increased their distance from the centre (though by ever so little), they would for ever have receded from it. Thus, the laws of attraction by which a system of revolving bodies could be maintained in their motions lie within narrow limits, compared with the possible laws.

Thirdly, out of the different laws that lie within the limits of admissible laws, the best is chosen; there are advantages in this particular law that cannot be demonstrated to belong to any other law, and some of them can be demonstrated not to belong to any other. [Paley tries to make good on this with several dauntingly obscure pages arguing that various good aspects of our situation depend on matter's being subject to, precisely, the inverse square-of-the-distance law. Then:]

To conclude: In astronomy the great thing is to raise the imagination to the subject, often in opposition to the impression made on the senses. For example, the distance at which we view the heavenly bodies creates an illusion that they move slowly. The moon takes some hours to get half a yard from a star that it touched, and we may think that a motion so deliberate is easily guided. But in fact the moon is driving through the heavens at considerably more than 2,000 miles an hour; which is more than double the speed which a ball is shot from the mouth of a cannon. Yet this prodigious speed is as much under government as if the planet were conducted in its course inch by inch. It is also difficult to bring the imagination to conceive (as we must if we are to judge tolerably of the matter) how loose, so to speak, the heavenly bodies are. Enormous globes, held by nothing, confined by nothing, are set into free and boundless space, each to seek its course by the virtue of an invisible principle [see Glossary]; a single principle, the same in all; and ascertainable. To

- •preserve such bodies from being lost, from running together in heaps, from distracting one another's motions in a degree inconsistent with any continuing order; that is. to
- •cause them to form planetary systems that can be upheld, and are accommodated to the organised and sensitive natures that inhabit the planets, or at least our earth;

all this requires an intelligent interposition, because it requires an adjustment of force, distance, direction, and velocity that chance could not have produced. In the way it serves our utility, this adjustment is similar to what we see in ten thousand subjects of nature that are nearer to us, but it is stupendous in its power and in the extent of space through which that power is exerted.

Many of the heavenly bodies, such as the sun and fixed stars, are stationary. Their immobility must result from an absence of attractions or from an equilibrium of them; and it shows that a projectile impulse was originally given to some heavenly bodies and not to others. Also, if attraction acts at all distances, there can only be one immobile centre of gravity in the universe, and all bodies whatever must be •approaching this centre or •revolving round it. According to the first of these suppositions, if the duration of the world had been long enough, all the great bodies of which it is composed must have gathered together in a heap around this central point. But no changes have been observed that give us the smallest reason for believing that either the one (all-in-a-heap) supposition or the other (all revolving) is true. So we should conclude that attraction itself is controlled or suspended by a superior agent; that there is a power above the highest of the powers of material nature; a will that restrains and circumscribes the operations of everything.[1]

[1] Many astronomers deny that any of the heavenly bodies are absolutely stationary. Some of the brightest fixed stars certainly have small motions; and of the rest the distance is too great and the intervals of our observation too short for us to know for sure that they don't have the same. By a comparison of the motions of the fixed stars that have been observed, a motion of our system is supposed to be discovered. By continuing this analogy to all systems, it is possible to suppose that attraction is unlimited, and that the whole material universe is revolving round some fixed point within its containing sphere of space.

23. The personhood of the Deity

Contrivance, if established, appears to me to prove everything we want to prove. Among other things, it proves the personhood of the Deity. This distinguishes God from what is sometimes called 'nature', sometimes called 'a principle', terms that seem to be intended by those who use them philosophically, to admit an *efficacy* but to deny a *personal* agent. Now, contriving and designing can only be done by a person. These capacities constitute personhood, for they imply consciousness and thought. They require that which can perceive an end or purpose as well as the power of providing means and directing them to their end. They require a centre in which perceptions unite, and from which volitions flow; and that is *mind*. The acts of a mind prove the existence of a mind, and whatever a mind resides in is a person. We have no authority to limit the properties of mind to any particular bodily form or to any particular spatial limitation. In created nature, animated beings have a great variety of bodily shapes; and each has a certain portion of space within which perception and volition are exerted. This portion may be enlarged to an indefinite extent—may take in *the universe*—and imagining it like that may provide us with as good a notion as we can have of the immensity of the divine Nature, i.e. of a Being infinite in essence as well as in power; yet nevertheless a person.

'No man has seen God at any time.' And this, I believe, makes the great difficulty. Now, it is a difficulty chiefly arising from our not duly estimating the state of our faculties. The Deity, it is true, is not the object of any of our senses, but think about what limited capacities animal senses are. Many animals seem to have only one sense, or perhaps two at the most—touch and taste. Ought such an animal to conclude against the existence of odours, sounds, and colours? [He then goes through a series of suppositions of animals with more senses, remarking that each •might look down on those that have less but •ought not to think that anything it can't sense doesn't exist. The series ends with five senses:] This fifth sense makes the animal what the human animal is; but to infer that there are no more senses, or that the five take in all existence, is just as unwarrantable for a human being as it would be for any of the different species that had fewer than five senses.

The conclusion of the one-sense animal stands on the same authority as the ·unwarrantable· conclusion of the five-sense animal. There may be senses other than those we have. There may be senses suited to the perception of the powers, properties, and substance of spirits. These may belong to higher orders of rational agents, for there is no reason to suppose that we are the highest.

The great energies of nature are known to us only by their effects. The substances that produce them are as much concealed from our senses as the divine essence itself. Gravitation, though

- •constantly present,
- •constantly exerting its influence,
- •everywhere around us, near us and within us,
- •diffused throughout all space, and
- •penetrating the texture of all bodies we are acquainted with,

depends either on •a fluid which, though both powerful and universal in its operation, is no object of sense to us, or on •some other kind of substance or action from which we receive no distinguishable impressions. Is it to be wondered at, then, that it should be somewhat like that with the divine nature?

We are certain of this, however: whatever the Deity is, neither the visible universe nor any part of it can be He.

'The universe' itself is merely a collective name: its parts are all that are real, or that are things. Now inert matter is out of the question; and organised substances include marks of contrivance. But whatever includes marks of contrivance—whatever in its constitution indicates *design*—necessarily points to something beyond itself, to some other being, to a designer prior to and distinct from itself. No animal, for instance, can have contrived its own limbs and senses, causing the design with which they were constructed. That supposition involves all the absurdity of self-creation, i.e. of acting without existing. Nothing can be God that is indebted for any of its properties to contrivance by a wisdom and a will outside itself. The essential distinguishing property of the Deity, which removes his nature from that of all things we see, is what is sometimes called 'self-sufficiency' or 'self-comprehension', namely: **not having in his nature anything that requires the activity of another prior being**. This yields the answer to a question that has sometimes been asked, namely: Since something or other must have existed from eternity, why may not the present universe be that something? The contrivance perceived in the universe proves that to be impossible. Nothing contrived can strictly be eternal, because the contriver must have existed before the contrivance.

Wherever we see marks of contrivance, we are led for its cause to an intelligent author. And this transition of the understanding is based on uniform experience. We see intelligence constantly contriving; that is, we see intelligence constantly producing effects marked and distinguished by certain general properties such as relation to an end, and relation of parts to one another and to a common purpose. Where we are witnesses to things' actual formation, we see nothing except intelligence producing effects so marked and distinguished. Equipped with this experience, we view the productions of nature. We see them to be marked and distinguished in the same way; we want to account for their origin; our experience suggests a cause perfectly adequate for this; no experience—no single instance or example—can be offered in favour of any other. So we ought to settle for this cause; it is the one that the common sense of mankind has in fact settled, because it agrees with the undeviating course of mankind's experience, which is the foundation of all our knowledge. The reasoning is the same as that by which we infer that ancient appearances were effects of volcanoes or floods, namely that they resemble the effects that fire and water produce before our eyes, and we have never known these effects to result from anything else.

The force of the reasoning is, however, sometimes sunk by our taking up with mere names. I have already noticed [see page 2] the misapplication of the term 'law', and the mistake concerning the idea that term expresses in physics whenever such idea is made to take the place of power, and still more of an intelligent power, and thus taken to be the cause of any thing or property that exists. This is what we are secretly apt to do when we speak of organised bodies such as plants or animals as owing their production, their form, their growth, their qualities, their beauty, their use, to any laws of nature; and when we treat that as the final answer to our inquiries concerning them. I repeat that it is a perversion of language to assign any law as the operative cause of anything. A law presupposes an agent, for it is only the mode according to which an agent proceeds; it implies a power, for it is the order according to which that power acts. Without this agent and this power, the 'law' does nothing, is nothing.

What I have said about 'law' also holds for 'mechanism'. Mechanism is not itself power. Without power mechanism can do nothing. [He develops this at length: the 'mere wheels' of a watch don't explain its action; for that there has to be a spring driving it. Similarly, a hand-mill must have a hand driving it. Summing up:] It is the same in nature. In the works of nature we trace mechanism, and this alone proves contrivance. But living, active, moving, productive nature proves also the exercise of a power at the centre—for wherever the power resides may be called 'the centre'.

This also applies to the intervention and disposition of what are called 'second causes' [see Glossary]. Whether this disposition is mechanism depends on whether we can trace it by our senses and means of examination. Now, where the order of second causes is mechanical, what I have said about mechanism strictly applies to it. But it always *would* be mechanism—e.g. natural chemistry would be mechanism—if our senses were acute enough to detect it. So neither mechanism in the works of nature nor the intervention of so-called 'second causes' (really the same thing) removes the necessity for an agent distinct from both.

If it is said that in tracing these causes we find general properties of matter that have nothing in them indicating intelligence, I answer that nevertheless the managing of these properties—pointing and directing them to the uses we see made of them—demands intelligence in the highest degree. For example, suppose that animal secretions worked in a way that such-and-such substances always work in, with no intellect involved; still, choosing these substances and disposing them in the right places must be an act of intelligence. What harm would be done if there were a single transposition of the secretory organs, a single mistake in arranging the glands that compose them!

There may be many second causes, and many sequences of second causes one behind another, between what we observe of nature and the Deity; but there must be intelligence somewhere; there must be more in nature than what we see, the unseen things must include an intelligent, designing author. The philosopher [here = 'scientist'] beholds with astonishment the production of things around him. Unconscious particles of matter go their places and put themselves in an order so as to become collectively plants or animals, i.e. organised bodies, with parts bearing strict and evident relation to one another and to the utility of the whole; and it should seem that these particles could not move in any way other than how they do, for they show not the smallest sign of choice, liberty, or discretion. Perhaps intelligent beings guide these motions in each case; or perhaps they result from sequences of mechanical dispositions set up by an intelligent appointment and kept in action by a power at the centre. Either way, there must be intelligence.

Generation as a 'principle' in nature

The minds of most men are fond of what they call a 'principle', and of the *appearance* of simplicity ·that it provides· in accounting for phenomena. Yet the only thing that is simple in such a principle is the name, which covers a diversified, multifarious, or progressive operation that is distinguishable into parts ·and thus is not simple at all·. One of these principles is the power of organised bodies to produce bodies like themselves. Give a philosopher this and he can run with it. But he does not reflect what this mode of production—this 'principle' if that's what he chooses to call it—requires; what an apparatus of instruments, some of them strictly mechanical, is necessary for its success; what a sequence it includes of operations and changes, one related to another, one ministering to another, all advancing by intermediate (and frequently perceptible) steps to their final result! Because all this complicated action is wrapped up in a single term, 'generation', we are to set it down as an elementary principle, and to suppose that when we have brought the things we see under this principle we have sufficiently explained their origin, with no need for a designing, intelligent Creator. In fact, generation is not a principle but a process. We might as well call spinning and weaving 'principles' and then, claiming to explain the texture of cloths, the fabric of muslins and calicoes etc. in terms of them, claim to dispense with intention, thought and contrivance on the part of the artist—indeed, to dispense with the need for any artist at all, whether in the manufacturing of the article or in the fabrication of the machinery by which the manufacture was carried on. And, after all, in what sense is it true that animals produce their like? [He gives details of counterexamples: butterfly/caterpillar, frog/tadpole, beetle/worm, fly/maggot.]

The appeal to 'generation' as a principle in nature that fully explains the existence of organised bodies is confuted, in my judgment, not only by •every mark of contrivance discoverable in those bodies for which it gives us no contriver, but also by •the further consideration that generated things have a clear relation to things that are not generated. If it were merely one part of a generated body bearing a relation to another part of the same body, or one generated body bearing a relation to another generated body, it might be contended that all this correspondence was attributable to generation, the common origin from which these substances proceeded. But what are we to say about correspondences between generated things and things that are not generated? Can it be doubted that animals' lungs have a relation to the air as a permanently elastic fluid? If generation produced the animal, it did not produce the air; yet their properties correspond. The eye is made for light, and light for the eye. The eye would be of no use without light, and light perhaps of little without eyes; yet one is produced by generation and the other is not. Similarly with ears and air-waves.

If it be said that the world itself is generated, I answer that I do not understand. If the proposition uses 'generated' to mean something like what it means when applied to plants or animals, the proposition is certainly without proof and (I think) comes as near to absurdity as any proposition can do that does not include a contradiction in its terms.

We know a cause (intelligence) adequate to the appearances we wish to account for; we have this cause continually producing similar appearances; yet we are invited to reject this and resort to suppositions that don't have a single fact for their support and aren't confirmed by any analogy we are acquainted with. If we inquired into the motives of men's opinions—I mean their motives, not their arguments—I would almost suspect that the situation is this:

> The proof of a Deity drawn from the constitution of nature is not only widely accepted, but accepted by people with little education (which may be because of the proof's force, and thus be its highest recommendation); and befriending it seems almost childish. For these reasons, minds that are habitually in search of invention and originality are irresistibly inclined to strike off into other solutions and other expositions.

The truth is that many minds dislike nothing that can be offered to them as much as they dislike the flatness of being content with common reasons; and—what is most to be lamented—minds conscious of superiority are the most liable to this attitude.

The positions I am discussing have one thing in common: they all try to dispense with the necessity in nature of a particular, personal intelligence, i.e. with the role of an intending, contriving mind in the structure and formation of the organised constitutions the world contains. They all want to resolve productions simply into unconscious energies like attraction, magnetism, electricity, etc.

In this, the old system of atheism and the new agree. And I doubt whether the new schemes are in any way different from the old except in having changed the terms of the nomenclature. I could never see the difference between the antiquated system of atoms and Buffon's organic molecules. This philosopher, having used a single stroke of a comet to •make a planet by knocking off a piece of melted glass from the sun, and •set the planet in motion around its own axis and around the sun, finds his next difficulty to be how to bring plants and animals onto it. To solve this difficulty, we are to suppose the universe to be replenished with particles that have no organisation or senses of their own but are endowed with life and also with a tendency to marshal themselves into organised forms. The concourse of these particles, by virtue of this tendency, but without intelligence, will, or direction (for I do not find that any of these qualities are ascribed to them), has produced the living forms that we now see.

Internal moulds

Of the conjectures that philosophers hazard on these subjects, few have more to say for themselves than challenging you to show that they are absolutely impossible. In the present example ·of Buffon's theory· there seemed to be a positive objection to the whole scheme on the very face of it, namely that according to this theory new combinations ought to be perpetually taking place, new plants and animals—or organised bodies that were neither—ought to be starting up before our eyes every day. For this, however, our philosopher has an answer. While so many forms of plants and animals are already in existence, and consequently so many of his 'internal moulds' are available, the organic particles run into these moulds and are employed in bringing substance to them for their growth as well as for their propagation. In this way things keep on their former course. But, says the same philosopher, if any general loss or destruction of the present constitution of organised bodies were to take place, the particles would run into different combinations and make up for the loss with new species of organisms.

Is there any history to support this notion? Is any destruction known to have been so repaired? any desert thus re-peopled?

So far as I remember, the only natural appearance our author mentions in support of his hypothesis is the formation of worms in the intestines of animals. He ascribes this to the coalition of superabundant organic particles, floating about in the first passages, which have combined into these simple animal forms because of the lack of internal moulds into which they might be received. [Paley brushes this off as mere unsupported speculation, concluding:] It is seldom difficult to suggest methods by which the eggs or spawn or still-invisible rudiments of these vermin may have obtained a passage into the cavities where they are found. Add to this that their constancy to their species—which I believe is as regular in these as in the other species of worms—decides the question against our philosopher, if indeed any question remained on the subject.

Lastly, these wonder-working instruments, these 'internal moulds', what are they after all? One short sentence of Buffon's work exhibits his scheme as follows:

> 'When this nutritious and prolific matter that is diffused throughout all nature passes through the internal mould of an animal or vegetable and finds a proper matrix or receptacle, it gives rise to an animal or vegetable of the same species.'

Does any reader attach a meaning to the phrase 'internal mould' in this sentence? It might be said that, though we have little notion of an internal mould, we have not much more of a designing mind. But the very opposite of this assertion is the truth. When we speak of an 'artificer' or an 'architect', we talk of something comprehensible to our understanding and familiar to our experience. We use only terms whose meaning are grounded in our consciousness and observation; whereas names like 'internal mould' arouse no idea—merely convey a sound to the ear.

Appetencies

Another system that has recently been brought forward, and with much ingenuity, is that of appetencies [see Glossary]. The theory goes like this [to the end of this paragraph]: Pieces of soft, ductile matter, being endued with propensities or appetencies for particular actions, would by continual endeavours through a long series of generations work themselves gradually into suitable forms; and eventually acquire, perhaps by obscure and almost imperceptible improvements, an organisation fitted to the action their respective propensities led them to exert. A piece of animated matter endued with a propensity to fly, though ever so shapeless, would in a course of ages—if not in a million of years perhaps in a hundred million years (for our theorists, having eternity at their disposal, are never sparing in time)—acquire wings. The same tendency to locomotion in an animated lump that happened to be surrounded by water would end in the production of fins; in a living substance, confined to the solid earth it would put out legs and feet or break the body into ringlets and end up crawling on the ground.

I am unwilling to call this theory 'atheistic' for two reasons. **(a)** So far as I understand it, the original propensities and the countless varieties of them are attributed by the theory to the commands of an intelligent and designing Creator. **(b)** The theory presupposes the faculty [see Glossary] in living bodies of producing other bodies organised like themselves, and seems to attribute it to the same cause, or at least does not try to explain it in any other way. But the theory agrees with atheistic systems in one important respect, namely that it does away final causes [see Glossary] in the formation of plants and animals, in the structure and use of their parts. Instead of the parts of a plant or animal, or the particular structure of the parts, having been intended for the action or the use to which we see them applied, this theory holds they have themselves grown out of that action, sprung from that use. So it dispenses with the necessity in each particular case of an intelligent, designing mind to contrive and determine the forms of organised bodies. Give our philosopher these appetencies; give him a portion of living matter (a nerve, or the clipping of a nerve) to work on; give his incipient or progressive forms the power to propagate their like; and, if he is to be believed, he could replenish the world with all the vegetable and animal productions we at present see in it.

This scheme is open to the same objection as other conjectures of a similar tendency, namely a total lack of evidence. No changes like those the theory requires have ever been observed.

All the changes in Ovid's *Metamorphoses* could have been effected by these appetencies, if the theory were true; yet not an example—not even the claim of an example—is offered of a single change being known to have taken place. Nor is the order of generation obedient to the principle on which this theory is built. The nipples of the male have not vanished through disuse; nor have centuries of circumcision shortened the foreskins of Jews [Paley puts this last clause in Latin, giving it what Gibbon called 'the decent obscurity of a learned language']. It has been said that the process of alteration is too slow to be perceived; that it has been carried on through immeasurable tracts of time; and that the present state of things is the result of a gradation of which no human record can trace the steps. It is easy to say this, but it doesn't alter the fact that the hypothesis remains destitute of evidence.

The analogies that have been alleged, are of the following kind. [Paley cites three. The camel's hump, the featherless state of the legs of wading birds, and the pelican's pouch. He emphasises the third] because it is drawn from an active habit, whereas the other two were from passive habits. The description naturalists give of the pelican's pouch is as follows:

> 'From the lower edges of the under-chap hangs a bag, reaching from the whole length of the bill to the neck, which is said to be capable of containing fifteen quarts of water. The bird can wrinkle this bag up into the hollow of the under-chap. When the bag is empty it is not seen; but when the bird has fished with success, it fills the bag and then it returns to digest its burden at leisure. The bird preys on large fishes and hides them by dozens in its pouch.'

Now, this extraordinary conformation is nothing more, say our philosophers, than the result of habit—a habit perpetuated through a long series of generations. The pelican soon found the convenience of storing the remainder of its prey in its mouth when its appetite was glutted. The fulness produced by this attempt, inevitably stretched the skin between the under-chaps, as being the most yielding part of the mouth. Every distension increased the cavity. The original bird and many generations succeeding it might find it hard to make the pouch serve this purpose; but future pelicans, entering on life with a pouch of considerable capacity derived from their progenitors, would more easily speed its advance to perfection by frequently pressing down the sac with the weight of fish that it could now contain.

[Paley attacks all three examples, maintaining that each is 'open to great objections'. He presents these briefly, and then continues:] But the need to controvert the instances themselves is lessened by the fact that it is a straining of analogy beyond all limits of reason and credibility to assert that birds, beasts and fish—with all their variety and complexity of organisation—have been brought into their forms and sorted into their various kinds and natures by the same process as might seem to serve for the gradual generation of a camel's hump or a pelican's pouch.

When applied to the works of nature generally, this theory is contradicted by many of the phenomena, and totally inadequate to others. The ligaments by which the tendons are tied down at the angles of the joints could not possibly be formed by the motion or exercise of the tendons themselves, by any appetency arousing these parts into action, or by any tendency arising therefrom. The tendency is all the other way; the effort is in constant opposition to them. Length of time does not help the case; rather the reverse. Again, the valves in the blood-vessels could never be formed in the way our theorist proposes. The blood when flowing naturally has no tendency to form them; and when it is obstructed or flowing backwards it has the opposite tendency.

The origin of animals' senses seems to me altogether incapable of being explained in the way this theory proposes. Including under the word 'sense' the organ and the perception, we have no account of either. How will our philosopher get at vision, or make an eye? How should the blind animal affect [see Glossary] sight, of which blind animals have neither conception nor desire? And if it did affect it, by what operation of its will—what *endeavour to see*—could it determine the fluids of its body in such a way as to start the formation of an eye? And if the eye was formed, would the perception follow? The same for the other senses. And this objection holds its force, ascribe what you will to the hand of time, to the power of habit, to changes too slow to be observed by man. Concede what you like to all this, none of it will help you. No laws, no course of events, no powers of nature that prevail at present nor anything like them could *start* a new sense; and it is pointless to inquire about the progress of something that could never begin.

Finally, what do these appetencies mean when applied to plants? I cannot give a signification to the term that can be transferred from animals to plants or is common to both. Yet the organisation found in plants is as successful as what animals have. A solution is wanted for each.

On the whole, after all the schemes and struggles of a reluctant philosophy, the necessary resort is to a Deity. The marks of design are too strong to be overcome. Design must have had a designer. That designer must have been a person. That person is GOD.

24. The natural attributes of the Deity

It is an immense conclusion, that there is a GOD, a perceiving, intelligent, designing Being at the head of creation, and from whose will it proceeded. The attributes of such a Being must be adequate to the magnitude, extent and multiplicity of his operations, which are not only vast beyond comparison with those performed by any other power, but—so far as respects our conceptions of them—infinite, because they are unlimited on all sides.

Yet the contemplation of such an exalted nature, however securely we arrive at the proof of its existence, overwhelms our faculties; the mind feels its powers sink under the subject; and one result of this is that from •painful abstraction the thoughts seek relief in •sensible images. From this comes the ancient and almost universal propensity to idolatrous substitutions. They are the resources of a struggling imagination. False religions usually go along with this natural propensity; true religions, or ones derived from true religions, resist it.

One of the advantages of the revelations that we acknowledge is that while they reject idolatry with its many pernicious accompaniments, they introduce the Deity to human thought under an idea that is more personal, more determinate, more within the reach of humans than the theology of nature can provide. They do this by representing him exclusively in terms of his relation to ourselves; and, for the most part, in terms of some precise character resulting from that relation, or from the history of his providences. This suits the scope of our intellects much better than the universality that enters into the idea of God as deduced from the views of nature. So when these representations are well founded in point of authority (for all depends on that), they provide a condescension to the state of our faculties—·a coming down to the level of what we can manage·—which those who have reflected most on the subject will be the first to acknowledge to be both needed and valuable.

Nevertheless, if we are careful to imitate the documents of our religion by confining our explanations to what concerns ourselves, and do not aim for more precision in our ideas than the subject allows of, the various terms that are used to denote the Deity's attributes may be made, even in natural religion, to carry a sense consistent with truth and reason, and not surpassing our comprehension. The terms in question are: omnipotence, omniscience, omnipresence, eternity, self-existence, necessary existence, spirituality.

'Omnipotence' and 'omniscience are superlatives, expressing our conception of these attributes in the strongest and most elevated terms that language supplies—infinite power, infinite knowledge. We ascribe power to the Deity under the label '**omnipotence**', the strict and correct conclusion being that a power which could create such a world as this must be incomparably greater than any we experience in ourselves, than any we observe in other visible agents; greater also than any we can want, for our individual protection and preservation, in the Being on whom we depend. It is also a power to which we are not authorised by our observation or knowledge to assign any limits of space or duration.

Similar remarks apply to the term '**omniscience**'— infinite knowledge or infinite wisdom. Strictly speaking, knowledge is different from wisdom, because wisdom always supposes action, and action directed by it. With respect to knowledge, the Creator must know intimately the constitution and properties of the things he created; which seems to imply that he also has a foreknowledge of their action on one another, and of their changes that result from sequences of physical and necessary causes. His omniscience regarding things ·that are· present ·to him· is deducible from •his nature as an intelligent being joined with •the extent, or rather the universality, of his operations. Where he acts, he is; and where he is, he perceives. The wisdom of the Deity, as testified in the works of creation, surpasses all the ideas of wisdom we have drawn from the highest intellectual operations of the highest class of intelligent beings we are acquainted with; and (the main point for us) whatever its extent it must be sufficient for conducting the order of things under which we live. This is enough. It matters very little what terms we use to express our notion—or rather our admiration—of this attribute. Terms ·(like 'infinite')· that piety and linguistic usage have made habitual to us may be as proper as any other. The degree of knowledge and power required for the formation of created nature is not distinguishable by us from infinite.

The divine '**omnipresence**' stands in natural theology on the following foundation. In every place in the universe that we are acquainted with we perceive the exertion of a power, which we believe to proceed mediately or immediately from the Deity. In what part of space do we not discover attraction? In what regions do we not find light? In what accessible place on our globe do we not meet with gravity, magnetism, electricity, together with the properties and powers of organisms? Indeed, what corner of space is there in which we can examine something that does not indicate contrivance and design? This view of the world around us may give us the thought that *the laws of nature* prevail everywhere, that they are uniform and universal. But effects are produced by power, not by laws. A law cannot implement itself. A law refers us to an agent. Now, an agency so general that we cannot point to any place where no effect of its continued energy is found may—in popular language at least, and perhaps almost in philosophical strictness—be called 'universal'; and the person or Being in whom that power resides or from whom it is derived may—with nearly as much propriety—be said to be 'omnipresent'. He who upholds all things by his power may be said to be present everywhere.

'**Eternity**' is a negative idea clothed with a positive name. It supposes the present existence of what it is applied to, and denies a beginning or an end of that existence. As applied to the Deity, it has not been disputed by those who acknowledge a Deity at all. Most assuredly there never was a time when nothing existed, because that condition must have continued: nothing could rise up out of it, nothing could ever have existed since, nothing could exist now. In strictness, however, we have no concern with duration prior to that of the visible world. So all we need to know is that necessarily the contriver existed before the contrivance.

'**Self-existence**' is another negative idea, namely the negation of a preceding cause, progenitor, maker, author, creator.

'**Necessary existence**' means demonstrable existence.

'**Spirituality** ' expresses an idea that is partly negative and partly positive. The negative part consists in the exclusion of some of the known properties of matter, especially solidity, inertia, and gravitation. The positive part comprises perception, thought, will, power and *action*. That last term refers to the origination of motion, which is perhaps the quality that contains the essential superiority of spirit over matter, 'which cannot move unless it is moved, and cannot but move when impelled by another' ·(to quote Bishop Wikins)·. I see no difficulty in applying to the Deity both parts of this idea.

25. The unity of the Deity

What shows the Deity's unity is the uniformity of plan observable in the universe. The universe itself is a system, each part relating to other parts by •dependence or •connection through some common law of motion or •the presence of some common substance. Philosophers demonstrate that *one* principle of gravitation causes a stone to drop towards the earth and the moon to wheel round it, and that *one* law of attraction carries all the different planets around the sun. There are also other points of agreement among the planets that may be regarded as marks of the identity—·the oneness·—of their origin and of their intelligent author. In all are found the convenience and stability derived from gravitation. They all experience vicissitudes of days and nights, and changes of season. They all—at least Jupiter, Mars and Venus—have the same advantages from their atmosphere as we have. In all the planets the axes of rotation are permanent. Nothing is more probable than that the same attracting influence, acting according to the same rule, reaches to the fixed stars; but if this is only *probable*, it is *certain* that the same element of light does. The light from a fixed star affects our eyes in the same way, is refracted and reflected according to the same laws, as the light of a candle. The velocity of the fixed stars' light is the same as the velocity of the sun's, reflected from the satellites of Jupiter. The heat of the sun is of exactly the same kind as the heat of a coal fire.

In our own globe, the case is clearer. [He lists some of the samenesses, and sums up:] We never encounter modes of existence that are so totally different as to indicate that we have come into the province of a different Creator or under the direction of a different will. *One* atmosphere invests all parts of the globe, *one* sun illuminates, *one* moon exerts its specific attraction on all parts. If there is variety in natural effects—e.g. in the tides of different seas—that variety results from the same cause acting under different circumstances. In many cases this is proved; in all it is probable.

The inspection and comparison of living forms adds countless examples to this argument. The structure of all large terrestrial animals is very much alike; their senses nearly the same; their natural functions and passions nearly the same; their viscera nearly the same in substance, shape and office; the great circulating fluid is the same, for I don't think any difference has been discovered in the properties of blood, whatever animal it be drawn from. The skeletons of the larger terrestrial animals show particular varieties, but still under a great general affinity. The resemblance between quadrupeds and birds is somewhat less, yet sufficiently evident. They are all alike in five respects for every one in which they differ.

In fish the points of comparison become fewer, but we never lose sight of our analogy. [He gives examples, and mentions whales as connecting ‘the provinces of water and earth’.]

Insects and shell-fish appear to me to differ from other classes of animals the most widely of any. Yet even here, along with beside many points of particular resemblance, there is a general relation of a peculiar kind. It is the relation of inversion, the law of contrariety: whereas in other animals the bones the muscles are attached to lie within the body, in insects and shell-fish they lie outside it. [He gives details.] All of which (under wonderful varieties, indeed, and adaptations of form) points to an imitation, a remembrance, a carrying on, of *one* plan.

These observations are equally applicable to plants, but I don’t think I need to pursue that. It is a very striking circumstance, and alone sufficient to prove everything I am contending for here, that in this part of organised nature the sexual system is continued.

However, it is certain that the whole argument for the divine unity shows only a unity of *counsel*, ·and not a unity of *action*·. I have to acknowledge that I have no arguments to exclude the ministry of subordinate agents. If there are any such, they act under a presiding and a controlling will; because they act according to certain *general* restrictions, by certain *common* rules, and apparently on a *general* plan. Still, it may be that such agents—and different ranks, classes and degrees of them—are employed.

26. The goodness of the Deity

The proof of divine goodness rests on two propositions, each capable of being made out by observations drawn from the appearances of nature.

(1) In a vast plurality of instances in which contrivance is perceived, the design of the contrivance is beneficial.

(2) The Deity has added *pleasure* to animal sensations, beyond what was necessary for any other purpose, or when the purpose could have been achieved through pain.

[Paley now defends **(1)** at length. He will start to address **(2)** on page 86.]

No productions of nature display contrivance so clearly as the parts of animals, and I believe that the parts of animals all have a real subservience to the use of the animal—and nearly always one that we know and understand. When the multitude of animals is considered, the number of parts in each, their shape and fitness, the faculties depending on them, the variety of species, the complexity of structure, the frequent success and felicity of the result, we cannot reflect without the profoundest adoration on the character of the Being from whom all these things have come. We cannot help acknowledging what an exertion of *benevolence* creation was—a benevolence so minute in its care, so vast in its scope!

When I appeal to animals’ parts and faculties, and to their limbs and senses in particular, I think I am taking the proper route to the conclusion I want to establish. I do not say that the insensible parts of nature are made solely for the sensitive parts; but I do say that the only way we can consider the benevolence of the Deity is in relation to sensitive beings. Without this relation, ‘benevolent’ has no meaning. Dead matter is nothing. So the limbs and senses of animals—although they constitute only a small portion of the material creation—are all we have to attend to in thinking about the disposition of nature’s author, since they alone are instruments of perception. It is in these that we are to seek his character. It is by these that we are to prove that the world was made with a benevolent design.

‘It is a happy world, after all’

Nor is the design abortive. It is a happy world after all. The air, the earth, the water, teem with delighted existence. In a spring noon or a summer evening, wherever I look I see myriads of happy beings. Swarms of newborn flies are trying their pinions in the air. Their sportive motions, their wanton mazes, their gratuitous activity, their continual change of place without use or purpose, tell us of their joy and the exultation they feel in their recently discovered faculties. Probably the whole winged insect tribe are equally intent on their proper employments, and perhaps equally gratified by the offices [see Glossary] the Author of their nature has assigned to them. Other species are running about with an alacrity in their motions that bears every mark of pleasure. Large patches of ground are sometimes half covered with these brisk and sprightly natures. If we look to what the waters produce, shoals of baby fish frequent the margins of rivers, lakes, and the sea. These are so happy that they don’t know what to do with themselves.

It seems to me that the young of all animals get pleasure simply from the exercise of their limbs and bodily faculties, without reference to any end to be attained. A child, without knowing anything of the use of language, is highly delighted with being able to speak, and with its first successful attempts to walk, or rather to run (which precedes walking). It is delighted with speaking, while having nothing to say; and with walking, while not knowing where to go.

How happiness is distributed

But it is not for youth alone that the great Parent of creation has provided. Happiness is found with the purring cat as much as with the playful kitten; in the armchair of dozing age, as well as in the sprightliness of the dance or the animation of the hunt. The place of

- novelty,
- acuteness of sensation,
- hope, and
- ardour of pursuit

is taken by the perception of ease, which is to a considerable degree an equivalent for them all. This is precisely the difference between the young and the old. The young are happy only when enjoying pleasure; the old are happy when free from pain. And this state of affairs fits with the degrees of animal power that they respectively possess. The vigour of youth was to be stimulated to action by impatience of rest; while quietness and repose become positive gratifications to the incompetence of age. In one important respect the advantage is with the old. A state of ease is usually more attainable than a state of pleasure, so a constitution that can enjoy ease is preferable to one that can taste only pleasure. This same perception of ease oftentimes makes old age a condition of great comfort, especially when riding at its anchor after a busy or tempestuous life.

What is seen in different stages of the same life is still more exemplified in the lives of different animals. Animal enjoyments are infinitely diversified. The modes of life to which the organisation of different animals respectively determines them are not only varied but of opposite kinds. Animals of prey live much alone; animals of a milder constitution live in society; yet each is happy.

You may say that the instances I have cited, of vivacity or repose or of apparent enjoyment derived from either, are just selected favourable instances. I answer that **(a)** they are instances that comprise large provinces of sensitive existence; that every case I have described is the case of millions; and that **(b)** throughout the whole of life, as it is diffused in nature and as far as we are acquainted with it, the plurality and preponderance of sensations is in favour of happiness by a vast excess. In our own species, where the assertion may be more questionable than in any other, the predominance of good over evil [see Glossary]—e.g. of health and ease over pain and distress—is shown by our reaction to calamities. What inquiries the sickness of our friends produces! What conversation their misfortunes! This shows that the common course of things is in favour of happiness: that happiness is the rule, misery the exception. If the order were reversed, our attention would be called to examples of health and competence instead of disease and want.

One great cause of our unawareness of the Creator's goodness is the very extensiveness of his bounty. We do not greatly prize anything that we share with the general run of our species. When we hear of 'blessings', we immediately think of successes, prosperous fortunes, honours, riches, preferments, i.e. of *superiorities over others* that we happen to have or to be in pursuit of. The common benefits of our nature entirely escape us. Yet these are the great things. They constitute what most properly ought to be accounted blessings of Providence. Nightly rest and daily bread, and the ordinary use of our limbs and senses and understandings, are incomparably greater gifts than any other. But because almost everyone we encounter has them, we leave them out of our list of blessings. They raise no feelings, they move no gratitude. In this our judgment is perverted by our selfishness. A blessing ought in truth to be more satisfactory, or at least the bounty of the donor more conspicuous, by its very diffusion, commonness, cheapness; by its forming the happiness of most of our species as well as of ourselves. Even when we do not have it, we ought to be thankful that others do. But we have a different way of thinking. We see nothing but what has distinction to recommend it. This necessarily—and most unjustly—contracts our views of the Creator's beneficence within a narrow compass. The scope of the divine benignity is perceived in things that are so common as to be no distinction.

Pain and privations

But pain and privations exist, in numerous instances, and to a degree that would be very great if they were compared with anything but the mass of animal enjoyment. In judging my proposition **(1)** on page 79 in terms of the mixed state of things that these exceptions involve, two rules are necessary. Both of them are, I think, just and fair. **(i)** We should give weight only to effects that are accompanied by proofs of intention. **(ii)** When we cannot resolve all appearances into benevolence of design, we should make the few give place to many, the little to the great, basing our judgment on a large and decided preponderance if there is one.

Allow me to insert here what I have said on this subject in my *Moral Philosophy*.

·EXCERPT FROM PALEY'S 'MORAL PHILOSOPHY'·

When God created the human species, either he wished their happiness, or he wished their misery, or he was indifferent and unconcerned about either.

If he had wished our misery, he might have made sure of his purpose by forming our senses to be so many sores and pains to us, as they are now instruments of gratification and enjoyment; or by placing us amidst objects so ill-suited to our perceptions as to have continually offended us, instead of ministering to our refreshment and delight. He might, for example, have made everything we tasted bitter; everything we saw, loathsome; everything we touched, a sting; every smell, a stench; and every sound, a discord.

If he had not cared about our happiness or our misery, no *design* will have been at work and we must attribute to sheer good luck •the capacity of our senses to receive pleasure and •the supply of external objects fitted to produce it. But either of these is too much to be attributed to luck; so nothing remains but the first supposition, that when God created the human species he wished their happiness, and for that purpose made for them the provision that he has made.

The same argument may be proposed in different terms, as follows. Contrivance proves design, and the predominant tendency of the contrivance indicates the disposition of the designer. The world abounds with contrivances, and all the ones we are acquainted with are directed to beneficial purposes. Evil, no doubt, exists; but so far as we can see it is never the object of contrivance. Teeth are contrived to eat, not to ache; their aching now and then is incidental to the contrivance, perhaps inseparable from it. If you insist, call it a *defect in* the contrivance; but it is not the *object of* it. This distinction deserves to be attended to. In describing farming implements you would hardly say that the sickle is made to cut the reaper's hand, though it often does that, because of its construction and the way it is used. But if you had occasion to describe instruments of torture or execution, you would say that this engine is to stretch the sinews, this to dislocate the joints, this to break the bones; this to scorch the soles of the feet. Here, pain and misery are the very objects of the contrivance. Now, nothing like this occurs in the works of nature. We never discover a sequence contrived to bring about an evil purpose.

·End of excerpt from 'Moral Philosophy'·

The two cases that seem to me to look most like exceptions to the thesis of divine benevolence are those of •venomous animals, and of •animals preying on one another. These properties of animals must, I think, be regarded as designed; because in all cases of the first and in most cases of the second there is a distinct organisation provided for producing them. So we cannot avoid the difficulty by saying that the effect was not intended. The only question open to us is whether it is ultimately evil [see Glossary]. From the confessed and felt imperfection [see Glossary] of our knowledge, we ought to presume that there may be consequences of this economy that are hidden from us; from the benevolence that pervades the general designs of nature, we ought also to presume, that if these consequences could enter into our calculation they would turn the balance on the favourable side. Both these I contend to be reasonable presumptions. They would not be reasonable if these two cases were the only ones nature presented to our observation; but they are reasonable because the cases in question are combined with a multitude of other intentions, all of the same author and all directed to ends of undisputed utility.

I now offer what vindications of this economy that I can find, to lessen the difficulty.

Venomous bites and stings

(a) Considering just the animal itself, the faculty complained of is good, because it is conducive in all cases to the defence of the animal, in some cases to the subduing of its prey, and in some (probably) to killing the prey before sending it to the predator's stomach.

(b) You may say that this provision, when it comes to the bites that are deadly even to human bodies and to those of large quadrupeds, is greatly overdone; that it might have served its purpose yet been much less deleterious than it is. Well, I believe there are very few cases of bites producing death in large animals (of stings I think there are none).

The Abbé Fontana found that it required the action of five exasperated vipers to kill a dog of a moderate size, but that for the killing of a mouse or frog a single bite was sufficient; which agrees with the use I assign to the faculty. The Abbé seemed to hold that even the bite of the rattlesnake would not *usually* be mortal.

(c) It has been pointed out that while only a few species of serpents have the venomous property, the property guards the whole tribe. The most innocuous snake is avoided with as much care as a viper. The terror with which large animals regard this class of reptiles is its protection; and this terror is based on the formidable revenge that a small proportion of them are capable of taking. Linnaeus describes 218 species of serpents, of which only 32 are poisonous.

(d) It seems to me that animal constitutions are provided not only for •each element but for •each state of the elements, i.e. for every climate and every temperature; and that part of the trouble complained of arises from animals occupying situations on the earth that do not belong to them and were never intended for their habitation. This is especially true of the human animal. Driven by consequences of the folly and wickedness of mankind, multitudes of species have sought a refuge among burning sands, while countries blessed with hospitable skies and fertile soils remain almost without a human tenant. We invade the territories of wild beasts and venomous reptiles, and then complain that we are infested by their bites and stings! Adanson writes: 'The ·African· deserts are entirely barren, except where they produce serpents, and in such quantities that some extensive plains are almost entirely covered with them.' These are the natures appropriated to the situation. Let them enjoy their existence; let them have their territory. Even if man's numbers increase a hundred-fold, there will be surface enough left for him where he can live exempt from these annoyances.

Animal predation

The second case, namely animals devouring one another, needs much more thought. To judge whether this can be deemed an evil, even so far as we understand its consequences (which probably isn't very far), the following reflections are worth attending to. [They run until page 86.]

(a) Immortality on this earth is out of the question. Without death there could be no generation, no sexes, no parental relation, i.e. as things are constituted, no animal happiness. The particular duration of life assigned to different animals can form no part of the objection. While that duration remains finite, the question can always be raised as to why it is not longer. The natural age of different animals varies from one day to 100 years. No account can be given of this.

So, taking the life-spans of different animals as a given, the question is: What method of taking life away is the best for the animal itself?

According to the established order of nature—which we must suppose to prevail, or we cannot reason at all on this subject—the three methods by which life is usually ended are **a** acute diseases, **b** decay, and **c** violence. The simple and natural life of brutes [see Glossary] is not often visited by **a** acute illnesses, nor would it be an improvement for them if it were. Think, then, about the condition of suffering and misery a brute animal is placed in when it is left to perish by **b** decay. In its wild and natural state it does everything for itself; so when its strength, or speed, or limbs, or senses fail it, the animal is delivered over to absolute famine or to the protracted wretchedness of a life slowly wasted by the scarcity of food. Do you want to alter the present system of **c** pursuit and prey so as to see the world filled with drooping, superannuated, half-starved, helpless, and unhelped animals?

(b) The predatory system is a spring of motion and activity on both sides. The pursuit of its prey forms the employment, and appears to constitute the pleasure, of a considerable part of the animal creation. Using the means of defence, flight, or precaution forms the business of another part. And even of this latter tribe—the prey—we have no reason to suppose that their happiness is much damaged by their fears. Their danger exists continually, and sometimes they seem to be aware of it sufficiently to provide against it in the best way they can; but it is only when the attack is actually made on them that they appear to suffer from it. Contemplating the insecurity of their condition with anxiety and dread would require a degree of reflection which (happily for themselves) they do not possess. Despite the number of its dangers and its enemies, the hare is as playful an animal as any other.

(c) To do justice to the question, the system of animal destruction ought to be considered in connection with another property of animal nature, namely *superfecundity*. They are countervailing qualities. My task, then, will be **[A]** to point out the advantages gained by the powers in nature of a superabundant multiplication; and **[B]** to show that these advantages are reasons for setting up the system of animal hostilities that I am trying to account for.

The advantages of large numbers

[A] In almost all cases nature produces its supplies with profusion. In one season a single cod-fish spawns more eggs than there are people in England; and I could list a thousand other instances of prolific generation which, though not equal to this, would still make the point. This has two advantages: •it tends to keep the world always full, and •it allows the proportion between different species of animals to be varied as different purposes require or as different situations provide space and food for them. Where this vast fecundity meets with a vacancy fitted to receive the species, there it operates with its whole effect, pouring in its numbers and filling the gap. We complain of the 'exorbitant' multiplication of some troublesome insects, not reflecting that large portions of nature might be left void without it. Immense tracts of forest in North America would be nearly lost to sensitive existence (solitude and death-like silence) if it were not for gnats (animation, activity, enjoyment, a world that is busy, happy, and peopled). Again, hosts of mice are reckoned among the plagues of north-eastern Europe, whereas vast plains in Siberia would be lifeless without them. The Caspian deserts are converted by their presence into crowded warrens. Between the Volga and the Yaik the ground is in many places covered with little hills, raised by the earth cast out in forming the burrows. Do we envy these blissful abodes so much that we pronounce the fecundity by which they are supplied with inhabitants to be an evil, a subject of complaint and not of praise?

This fruitfulness also allows the proportion between the species of animals to be differently modified, as different purposes of utility may require. When the forests of America come to be cleared and the swamps drained, our gnats will give place to other inhabitants. If the population of Europe should spread to the north and the east, the mice will retire before the farmer and the shepherd, and yield their place to herds and flocks. As for the human species: it may be a part of the scheme of Providence that the earth should be inhabited by a shifting—or perhaps circulating—population, an economy that may have the following advantages. When old countries become exceedingly corrupt, simpler modes of life, purer morals and better institutions may rise up in new countries, where fresh soils reward the cultivator with more plentiful crops. In this way different portions of the globe come into use successively as the residence of man; and in his absence entertain other guests which fill the chasm by their sudden multiplication. The fecundity of domesticated animals means that we can always control their numbers, having as many of a species as we please or as we can support.

Controlling large numbers

[B] But then this superfecundity, though very useful and important in some circumstances, exceeds the ordinary capacity of nature to receive or support its progeny. All superabundance must come with destruction or else destroy itself. There may be no species of terrestrial animals that would not overrun the earth if it were permitted to multiply in perfect safety; or species of fish that would not fill the ocean if it were left to its natural increase without disturbance or restraint. So the effects of such prolific faculties have to be curtailed. In conjunction with other checks and limits, all serving the same purpose, are the thinnings that take place among animals by their action on one another. In some instances *we* directly experience the use of these hostilities: one species of insects rids us of another species or reduces its numbers; a third species may keep the second within limits; and birds or lizards are a defence against the inordinate increase by which even the third might infest us. In other instances—more numerous and possibly more important—this disposition of things may be necessary and useful to certain other species. It may even prevent the loss of certain species from the universe, a misfortune that seems to be carefully guarded against. There may be the appearance of failure in some of the details of Nature's works, in its great purposes there never are. Its species never fail. The original provision for continuing the replenishment of the world has proved itself effectual through a long succession of ages.

The system of destruction among animals is related to the system of fecundity as parts of a single compensatory scheme [see chapter 16]. In each species, the fecundity is proportional to the smallness of the animal, to the weakness and shortness of its natural term of life, and to the dangers and enemies it is surrounded by. An elephant produces only one calf; a butterfly lays six hundred eggs. Birds of prey seldom produce more than two eggs; sparrows and ducks frequently sit on a dozen. In the rivers we meet with a thousand minnows for one pike; in the sea, a million of herrings for a single shark. Compensation obtains throughout. Defencelessness and devastation are repaired by fecundity.

I have dwelt at length on these considerations because the system of animals devouring one another is the main if not the only instance in the Deity's works where questions can be raised about the utility of an economy that is stamped by marks of design. The case of venomous animals is much less weighty than the case of predation, and, in some degree is also included under it. In both cases there are probably many reasons that we do not know about.

Of the two propositions announced on page 79, my first was the one I have been defending up to here, namely that **(1) in a vast plurality of instances in which contrivance is perceived, the design of the contrivance is beneficial**. The second proposition is that **(2) the Deity has added *pleasure* to animal sensations, beyond what was necessary for any other purpose, or when the purpose could have been achieved through pain**.

This second proposition may be thus explained. The capacities which are necessary (according to the established course of nature) to support or preserve an animal, however obviously they may result from an organisation contrived for that purpose, must be seen as an act of the will that decreed the existence of the animal itself; because *these* capacities had to be given if the animal was to exist at all—and this is true whether the creation came from a benevolent or a malevolent being. So animal properties of this kind do not strictly prove the goodness of God. They may prove the existence of the Deity; they may prove a high degree of power and intelligence; but they do not prove his goodness, because they would have to have been present in any creation that was capable of continuance, and such a creation could have been produced by a being whose views rested on misery.

Gratuitous pleasures

But one class of properties can be said to be added through an intention expressly directed to happiness—an intention to give a happy existence, not merely the general intention to provide the means of existence. I am talking about capacities for pleasure in cases where they do not contribute to the conservation of the individual or of the species, or what they contribute could have been secured instead by the operation of pain. The provision of these capacities shows a design additional to the design of giving existence.

A single instance will make all this clear. Assuming the necessity of food for the support of animal life, the animal must be provided with organs fitted for procuring, receiving and digesting its food. It may be also necessary that the animal be impelled by its sensations to use its organs. But the pain of hunger would do all this; why add pleasure to the act of eating, sweetness and tastiness to food? Why a new and appropriate sense for the perception of the pleasure? Why should the juice of a peach applied to the palate affect the part so differently from what it does when rubbed on the palm of the hand? So far as I can see, this is a constitution that can be explained only through the pure benevolence of the Creator. Eating is necessary; but the pleasure that comes with it is not necessary; and this pleasure depends not only on our having the sense of taste, which is different from every other, but on a particular state of the organ it resides in. This felicitous adaptation of the organ to the object will be admitted by anyone who has ever experienced the vitiation of taste that frequently occurs in fevers, when every taste is irregular, everything tastes bad.

You may think that the gratifications of the palate are a trivial example. I do not agree. They provide a share of enjoyment to man, but to brutes they are of very great importance, I believe. A horse at liberty passes a great part of its waking hours in eating. To the ox, the sheep, the deer and other ruminating animals the pleasure is doubled. Their whole time almost is divided between browsing on their pasture and chewing their cud. Whatever the pleasure is, it is spread over a large portion of their existence. If there are animals such as the lupus fish—which swallows its prey whole and immediately, without taking any time to draw out or enjoy the taste in the mouth—isn't it probable that their seat of taste is in the stomach? or at least that a sense of pleasure of some kind accompanies the slow dissolution of the food in that receptacle? If this conjecture is right, they are more than repaid for the lack of palate, because the feast lasts as long as the digestion.

I need not spend time insisting on the comparative importance of the sense of taste, for my point holds equally for at least three of the other senses. The necessary purposes of hearing might have been satisfied without harmony, of smell without fragrance, of vision without beauty. Now, if the Deity had not cared about our happiness or misery, we must regard •the capacity of our senses to receive pleasure and •the supply of external objects fitted to arouse it, to *good luck*.

These are *two* felicities, both necessary but different from one another: the sense being formed, the objects applied to it might not have suited it; and the objects being fixed, the sense might not have agreed with them. There must be an explanation for the *fit* between them, and there are just three possible explanations. **a** The sense was made by its original constitution to suit the object. **b** The object was made by its original constitution to suit the sense. **c** The sense is so constituted that it can—universally, or within certain limits—make any object pleasant through habit and familiarity. Each of these three would show a studious benevolence on the part of the Author of nature. If the pleasures we get from any of our senses depend on **a b** an original congruity between the sense and the properties perceived by it, we know by experience how much the pleasure could be spoiled by changes in the qualities of the objects that surround us, and almost as much by changes in the intensity of our perception of those qualities. This matter of intensity is no arbitrary thing; to preserve the congruity I am speaking of, there has to be an exact or nearly exact correspondence with the strength of the impression. The dullness of the senses forms the complaint of old age. Persons in fevers and (I believe) in most maniacal cases experience great torment from the abnormal acuteness of their senses. An increased sensibility induces a state of disease and suffering as much as an impaired one does.

The doctrine of a specific congruity between animal senses and their objects is strongly favoured by what we see of insects in their choice of food. [He gives examples.]

But if we accept **c** the third hypothesis, and even carry it so far as to ascribe to habit *everything* I am now talking about—

> as in certain species, the human species most particularly, there is reason to ascribe *something* to habit

—we have then before us an ·acquired· animal capacity that is perhaps just as admirable as the *native* congruities that the other scheme adopts. It cannot be shown to result from any fixed necessity in nature that what is frequently applied to the senses should inevitably become agreeable to them. If that *is* how things stand, this is a perfection in these senses, provided by the Author of their structure.

However we regard the senses, they seem to be specific gifts ministering to preservation and also to pleasure. But what we usually call 'the senses' are probably far from being the only vehicles of enjoyment. We have many very agreeable internal sensations that can hardly be referred to any of the five senses. Some physiologists have held that all secretion is pleasurable, and that the general satisfaction we derive from life itself (when we are in good health) results from our secretions going on well within us. If this is true, what reason can be assigned for it except the will of the Creator? *Why is anything a pleasure?* is a reasonable question, and the only answer I know says that it was *decided* that this should be so.

We cannot explain our pleasures in terms of the simple and original perception. Even when physical sensations are involved, we can seldom account for them in the secondary and complicated shapes in which they count as 'diversions'. I have never met a sportsman who could tell me what the sport consisted in, stating the principle [see Glossary] that drives it. I myself have been a great follower of fishing, and in its cheerful solitude have passed some of the happiest hours of a sufficiently happy life; but I still cannot trace out the source of the pleasure it provides me with.

The exclamation *quantum in rebus inane!* [= "How much trivial stuff there is in the world!'], whether applied to our amusements or to our graver pursuits (to which indeed it sometimes equally applies), is always an unjust complaint. If trifles engage, and if trifles make us happy, the right way to respond to this is to reflect on nature's tendency to provide gratification and enjoyment, i.e. on the goodness of its Author towards his sensitive creation.

Rational natures also exhibit qualities that help to confirm the truth of what I am saying. The level of understanding found in mankind is usually much greater than what is needed for mere preservation. The pleasure of choosing for oneself and pursuing the object of one's choice seems to be an original source of enjoyment. The pleasures received from great, beautiful things—whether new or copied—are to some extent not only added but *unmixed* gratifications, having no pains to balance them. [He adds a paragraph about the pleasures of ownership; and then sums up with a reminder of his two propositions announced on page 79, concluding:] While these propositions can be maintained, we are entitled to ascribe benevolence to the Deity; and what is benevolence at all must in him be infinite benevolence, because of the infinite—i.e. incalculably great—number of objects on which it is exercised.

The origin of evil

For the origin of evil [see Glossary] no universal solution has been discovered—I mean no solution that covers all cases of complaint. **[A]** The most comprehensive solution is the one based on the consideration of general rules. I don't think it will be hard to get us to admit that

- **(i)** important advantages may accrue to the universe from the order of nature proceeding according to general laws;
- **(ii)** general laws, however well set and constituted, often thwart and cross one another;
- **(iii)** particular inconveniences will often arise from these thwartings and crossings;
- **(iv)** our observation shows us that some degree of these inconveniences takes place in the works of nature.

These points may be allowed; and it may also be asserted that the general laws that we know are directed to beneficial ends. On the other hand, we do not know many of these laws, or we cannot trace them in their branches and in their operation; so that they cannot be important to us as measures by which to regulate our conduct. The conservation of them may be important in other respects, or to other beings, but we are uninformed of their value or use; and consequently uninformed about when and how far they could be suspended or redirected by a presiding and benevolent will without incurring greater evils than those that would be avoided. The consideration of general laws, therefore, though it closely concerns the question of the origin of evil, depends on knowledge that we do not possess; so it serves to account for the obscurity of the subject rather than to provide us with clear answers to our difficulties. However, while we assent to the propositions **(i)**–**(iv)** as principles, whatever uncertainty we may find in the application, we lay a ground for believing that cases of apparent evil for which we can suggest no particular reason are governed by reasons that are more general, lie deeper in the order of second causes [see Glossary], and are therefore removed to a greater distance from us.

[B] The so-called doctrine of 'evils of imperfection' [see Glossary] is briefly as follows. It is probable that creation is better replenished by sensitive beings of different sorts than by sensitive beings all of one sort. It is also probable that it may be better replenished by •different orders of beings rising one above another in gradation than by •beings possessed of equal degrees of perfection. Now, a gradation of such beings implies a gradation of imperfections. No class can justly complain of the imperfections belonging to its place in the scale unless it were entitled to complain against there being any scale of being appointed in nature; and there appear to be reasons of wisdom and goodness for there being such an appointment. Similarly, finiteness in inanimate subjects can never be a just subject of complaint, because if it were ever so it would be always so; we can never reasonably demand that things should be larger or more, when the same demand could be made whatever the quantity or number was.

It seems to me that the sense of mankind has accepted these reasons to the extent that we seldom complain of evils of this kind when we clearly perceive them to be such. What I have to add, therefore, is that we ought not to complain of some other evils that can be vindicated in the same way as confessed evils of imperfection. We never complain that the globe of our earth is too small, nor would we even if it were much smaller. But what is the difference for us between •a smaller globe and •part of the actual globe being uninhabitable? The inhabitants of an island may murmur at the sterility of some parts of it, against its rocks, or sands, or swamps; but no-one thinks he is entitled to murmur simply because the island is not large than it is. Yet these are the same griefs.

[A] and **[B]** are the two metaphysical answers that have been given to this great question. They are not the worse for being metaphysical, provided they are founded (which I think they are) on right reasoning. But they are of a nature too wide to be brought under our survey, and it is often difficult to apply them in the detail; so our speculations are perhaps better employed when confined within a narrower circle.

The observations that follow are of this more limited but more determinate kind.

The main thing to be said about bodily pain, no doubt, is something I have already said and dwelt on, namely that it is seldom the object of contrivance; and that when it is so, the contrivance rests ultimately in good. [Paley puts this in quotation marks, but it does not come verbatim from anything he has said in this work. He is probably referring to page 82.]

I would add to this that annexing pain to the means of destruction is a *salutary* provision, because it teaches vigilance and caution; it warns of danger and arouses the endeavours that may be needed for preservation. The evil consequence that sometimes arises from the lack of the timely warning that pain gives is known to the inhabitants of cold countries by the example of frost-bitten limbs. Patients who have lost toes and fingers in this way have told me that they were totally unaware of anything wrong at the time, until they discovered, through the application of warmth, the fatal injury some of their extremities had suffered. This shows the use of pain, and shows that we need such a monitor.

Also, pain itself is not without its alleviations. It may be violent and frequent, but it is seldom both violent and long-continued, and its pauses and intermissions become positive pleasures. It can shed over intervals of ease a satisfaction that I think few enjoyments exceed. A man resting from a fit of the stone or gout has for a while feelings that undisturbed health cannot impart. They may be dearly bought, but still they are to be set against the price. Whether they *are* dearly bought depends on the duration and urgency of the pain. I think that a man may well be a gainer by suffering a moderate interruption of bodily ease for a couple of hours out of the 24. •Remissions of pain call forth from the sufferer stronger expressions of satisfaction and of gratitude towards both the author and the instruments of their relief than are aroused by advantages of any other kind; and •the spirits of sick men do not sink in proportion to the acuteness of their suffering, but rather appear to be roused and supported by the high degree of comfort they derive from its stopping or even lessening, whenever that occurs—a comfort their enjoyment of which spreads a degree of mental contentment over the whole mixed state of sensations that disease has placed them in.

In connection with bodily pain may be considered bodily disease, whether painful or not. Few diseases are fatal. I have before me the account of a dispensary in my neighbourhood, which states six years' experience as follows:

Admitted	6,420
Cured	5,476
Dead	234

And I suppose other similar institutions would have much the same statistics. In all these cases some disorder must have been felt, or the patients would not have applied for a remedy; yet we see how large a proportion of the maladies yielded to proper treatment or (more probably) ceased of their own accord. We owe these frequent recoveries, and (where recovery does not take place) this patience of the human constitution under many of the illnesses that come to it, to two benefactions of our nature. **(i)** The human constitution works within certain limits, permits a certain latitude within which health may be preserved with only slight lessenings. Different

- •quantities of food,
- •degrees of exercise,
- •portions of sleep,
- •states of the atmosphere

are compatible with good health. Similarly with the body's secretions and excretions and many of its internal functions, and probably with the state of most of its internal organs. They may vary considerably not only without destroying life but without causing any high degree of inconvenience. **(ii)** We are still more indebted to our nature's constant endeavour to restore itself, when disordered, to its regular course. For example, the body's fluids seem able to filter out and expel any noxious substance that gets mixed in with them.

Death

The great use of fatal diseases is to reconcile us to death. The horror of death proves the value of life. But a disease can lessen or even extinguish this horror, which it does in a wonderful way and often by a mild and imperceptible gradation. Every man who has been seriously ill is surprised with the change between •how he views death when he is on a sick-bed ands •the heart-sinking dismay with which he viewed it when in health. The sensations of a man led to execution are nothing like the calm expiring of a patient at the close of his disease. To the latter, death is only the last of a long sequence of changes, in the course of which he may experience no shocks or sudden transitions.

Death itself is so connected with the whole order of our animal world—as a mode of removal and of succession—that almost everything in that world would have to be changed to be able to do without it. It may seem impossible to separate the fear of death from the enjoyment of life, or to prevent rational natures from feeling that fear. Brutes are largely freed from anxiety on this account by the inferiority of their faculties; or rather they seem to be armed with the fear of death just enough to adopt means of preservation, and no further. But would a human being want to purchase this immunity at the cost of the mental powers that enable him to look to the future?

Death implies separation; and the loss of those whom we love must necessarily—so far as we can conceive—be accompanied by pain. For the brute creation, nature seems to have stepped in with some secret provision for their relief when their attachments are broken ·by death·. In their instincts towards their offspring and their offsprings' towards them, I have often been surprised to observe how ardently they love and how soon they forget. So the stubbornness of human sorrow (on which time at length lays its softening hand) is probably connected somehow with the qualities of our rational or moral nature. One thing however is clear:

> having affections, the sources of so many virtues and so many joys, although they are exposed to the incidents of life as well as the interruptions of mortality

is better than

> being reduced by the lack of them to a state of selfishness, apathy, and quietism.

Of other external evils (still confining ourselves to what are called physical or natural evils), many come within the scope of the following observation. The great principle [see Glossary] of human satisfaction is *engagement*. The late Mr Tucker was right to place so much emphasis in his works on the distinction between •pleasures in which we are passive and •pleasures in which we are active. And I think that every attentive observer of human life will agree with Mr Tucker that, however satisfactory the sensations in which we are passive may sometimes be, it is not these but the active pleasures that constitute satisfaction, supplying the regular stream of moderate and miscellaneous enjoyments in which happiness—as distinguished from voluptuousness—consists. So the very material of contented existence is *rational occupation*; and there would be no place for this if the things we engage with were **a** absolutely impracticable to our endeavours or **b** too obedient to our uses. The proper abode of free, rational, and active natures—the one fittest to stimulate and exercise their faculties—is a world provided with advantages on one side and beset with difficulties, wants, and inconveniences on the other. The very refractoriness of the objects we have to deal with contributes to this purpose. A world in which nothing depended on ourselves (however it might have suited an imaginary race of beings) would not have suited mankind. Their skill, prudence, industry; their various arts, and their best attainments, from the application of which they draw if not their highest their most permanent gratifications would be insignificant if things •were moulded by our volitions or •of their own accord conformed themselves to our views and wishes. Now, this refractoriness is the seed of all physical evil arising from things external to us.

Civil evils

Civil evils—the evils of civil life—are much more easily disposed of than physical evils, because •they are of much less magnitude and also because •they result, by a kind of necessity, from the constitution of our nature and from a part of it that no-one would wish to see altered. The case is as follows. Mankind will in every country breed up—·i.e. engage in population-increase·—to a certain point of distress. That point may be different in different countries or ages, according to the established patterns of life in each; but there must always be such a point, and the species will always breed up to it.

[In preparation for the next paragraph: in a geometrical series ('progression') there is some number n>1 such that each item in the series = the preceding number **multiplied** by n. An arithmetical series grows only by **addition**.]

The order of generation proceeds by something like a geometrical progression, whereas the increase of provision—even under the most advantageous circumstances—can only have the form of an arithmetic series. It follows that the population will always overtake the provision, will pass beyond the line of plenty, and will continue to increase until checked by the difficulty of getting enough to live on. Such difficulty, along with its accompanying circumstances, must therefore be found in every old country; and these circumstances constitute what we call 'poverty', which inevitably imposes labour, servitude, restraint.

It seems impossible to have a country whose inhabitants are all in easy circumstances. For suppose that we did: then there would be such marrying among them as would in a few years change the state of affairs entirely, increasing the consumption of things that supplied the natural or habitual wants of the country, and creating so much scarcity that most of the inhabitants could not procure such things without great labour or could procure only the most easily produced of them. That is in fact the condition of the mass of the community in all countries, a condition that seems to be an inevitable result of the provision that is made in the human constitution for the survival and growth of the species.

But it need not dishearten any endeavours for the public service to know that population naturally treads on the heels of improvement. If the condition of a people is improved, either •the average happiness will be increased or •more people will share in it, or—what is most likely to happen—•both effects will take place together. There may be limits fixed by nature to both, but they are limits not yet reached or even approached in any country of the world.

And when we speak of 'limits' we are talking only about providing for *animal* wants. There are sources, means, auxiliaries and augmentations of human happiness that can be spread around without restriction of numbers, as capable of being possessed by a thousand persons as of being possessed by one. Examples are those that

- •flow from a mild (contrasted with a tyrannical) government, whether civil or domestic;
- •arise from religion;
- •grow out of a sense of security;
- •depend on habits of virtue, sobriety, moderation and order; or
- •are found in the possession of well-directed tastes and desires, compared with the dominion of tormenting, pernicious, contradictory, unsatisfied and unsatisfiable passions.

The distinctions of civil life are apt enough to be regarded as evils by those who sit *under* them, but in my opinion there is very little reason for this.

In the first place, the advantages that the higher conditions of life are supposed to confer are tiny compared with the advantages bestowed by nature. The gifts of nature always surpass the gifts of fortune. How much better activity is than mere onlooking; beauty than dress; appetite, digestion and tranquil bowels than all the outputs of costly and far-fetched cookery!

Nature has a strong tendency to equalisation. Habit, the instrument of nature, is a great leveller because the familiarity it induces takes off the edge of our pleasures and of our sufferings. Indulgences that are habitual keep us in ease, and cannot do much more than that. So that, with respect to the gratifications the senses are capable of, the difference ·in gratification· is by no means proportional to the apparatus ·for getting it·. Indeed, to the extent that superfluity generates fastidiousness, the difference is on the wrong side.

It is not necessary to contend that the advantages derived from wealth are nonexistent (under appropriate regulations they are considerable), but that they are not greater than they ought to be. Money is the sweetener of human toil; the substitute for coercion; the reconciler of labour with liberty. It is, moreover, the stimulant of enterprise in all projects and undertakings, as well as of diligence in the most beneficial arts and employments. If affluence contributed nothing to happiness, or nothing beyond the mere supply of necessaries, and this secret came to be discovered, we would risk losing a great part of the uses that this important medium now brings us. The tranquillity of social life would be put in peril by the lack of a motive to attach men to their private concerns; and the satisfaction all men get from success in their respective occupations—which collectively constitutes the great mass of human comfort—would be abolished.

With respect to station [see Glossary] as distinct from riches—whether it confers authority over others or only involves honours that apply solely to sentiment and imagination—the truth is that what is gained by rising through the ranks of life is not more than enough to draw forth the exertions of those who are engaged pursuits that lead to advancement and that in general ought to be encouraged. Distinctions of this sort are matters of competition much more than of enjoyment, and that competition is what makes them useful. It has rightly been said that the public is served not by what the Lord Mayor feels in his coach but by what is felt by the apprentice who gazes at him.

As we approach the summits of human greatness, the comparison of good and evil with respect to personal comfort becomes still more problematical, even allowing to ambition all its pleasures. The poet asks 'What is grandeur, what is power?' The philosopher answers 'Constraint and plague, *et in maxima quaque fortuna minimum licere*' [Cicero, 'and in the highest fortune there is the least liberty']. One very common error misleads the opinion of mankind on this head, namely that authority is always pleasant, submission always painful. In the general course of human affairs the exact opposite of this is nearer to the truth. Command is anxiety, obedience ease.

Artificial distinctions sometimes promote real equality. Whether they are hereditary, or are the homage paid to office, or the respect attached by public opinion to particular professions, they serve to *confront* the distinction that arises from property and is most overbearing where there is no other ·to set against it·. It is of the nature of property to be irregularly distributed and to run into large masses. Public laws should be constructed so as to favour its diffusion as much as they can. But all that can be done by laws—consistently with the degree of control of his property that ought to be left to the subject—will not be enough to counteract this tendency. So there must always be the difference between rich and poor; and this difference will be the more grinding when no claim is allowed to be set up against it.

So that the evils (if that is what we must call them) that arise either from the necessary subordinations of civil life, or from the distinctions that have naturally though not necessarily grown up in most societies, so long as they are not accompanied by privileges injurious or oppressive to the rest of the community, can be endured even by the most depressed ranks with very little prejudice to their comfort.

The harms that mankind cause to one another, by

- their private wickednesses and cruelties,
- tyrannical exercises of power,
- rebellions against just authority,
- wars,
- national jealousies and competitions operating to the destruction of third countries, or
- other instances of misconduct either in individuals or societies,

are all to be attributed to the character of man as a free agent. Free agency in its very essence contains liability to abuse. But if you deprive man of his free agency you subvert his nature. You may have order and regularity from him, as you may from the tides or the trade-winds, but you put an end to his moral character, to virtue, to merit, to accountableness, indeed to the use of reason. To which I should add that even the bad qualities of mankind have an origin in their good ones. Human passions are either necessary to human welfare, or capable of being made (and in most cases are in fact made) conducive to mankind's happiness. These passions are strong and general, and perhaps would not answer their purpose unless they were so. But when particular circumstances need to be respected, **strength** and **generality** when left to themselves become **excess** and **misdirection**; and these appear to be the source of the vices of mankind, which are no doubt the causes of much misery. This account, while it shows us the principle [see Glossary] of vice, at the same time shows us the province of reason and of self-government; it shows the need for every support that can be procured to either from the aids of religion; and shows all this without attributing any native, gratuitous malignity in the human constitution. Mr Hume in his posthumous *Dialogues ·Concerning Natural Religion·* asserts that idleness or aversion to labour (which he says lies at the root of a considerable part of the evils mankind suffer) is simply and merely bad. But how does he distinguish idleness from the love of ease? Is he sure that the love of ease in individuals is not the chief foundation of social tranquillity? In every community, I think, there is a large class of its members whose idleness is the best quality about them, being the corrective of other bad ones. If it were possible to ensure that every instance of industry was rightly directed, we could never have too much of it. But this is not possible if men are to be free. And without this, nothing would be so dangerous as an incessant, universal, indefatigable activity. In the civil world as well as in the material world, it is inertia that keeps things in their places.

Why is there an appearance of chance?

Natural theology has always been pressed with the question: Why, under the government of a supreme and benevolent Will, should the world contain as much appearance of *chance* as it does?

The question in its whole compass lies beyond our reach; but as with the origin of evil there are plenty of answers that seem to have considerable weight in particular cases, and also to cover a considerable number of cases.

(1) There must be chance in the midst of design; by which I mean that events that are not designed necessarily arise from the pursuit of events that are designed.

One man travelling to York meets another man travelling to London. Their meeting is by chance, is accidental, though the journeys that produced the meeting were both undertaken with design and from deliberation. The meeting, though accidental, was nevertheless hypothetically necessary (which is the only sort of necessity that is intelligible); for if each journey was conducted in exactly the way it was in fact conducted, the meeting *could not* be avoided. So its being by chance does not lessen the necessity in it. Again, the meeting might be most unfortunate even if the errand on which each man set out on his journey was utterly innocent or even praiseworthy.

(2) The appearance of chance will always be proportional to the ignorance of the observer.

The cast of a die follows the laws of motion as regularly as does the running of a watch; yet, because we can trace the operation of those laws through the works and movements of the watch, and cannot trace them in the shaking and throwing of the die (though the laws are the same, and prevail equally in both cases), we call the turning up of the number of the die 'chance', and the pointing of the watch-hand 'machinery', 'order', or some name that excludes chance. It is the same in events that depend on the will of a free and rational agent. The verdict of a jury, the sentence of a judge, the resolution of an assembly, the issue of a contested election, will look more or less like chance, might be more or less the subject of a wager, according as we were less or more acquainted with the reasons that influenced the deliberation. The difference lies in the information of the observer, not in the thing itself, which in all those cases proceeds from intelligence, mind, counsel, design.

Apply this line of thought to the operations of the Deity and it is easy to foresee how fruitful it must prove in dealing with difficulties and seeming confusion. We have only to think of the Deity to perceive what variety of objects, what distance of time, what extent of space and action, his counsels may and indeed *must* cover. Is it any wonder that we should know such a small part of the purposes of such a mind as this? We ought to keep in mind the fact that the amount of apparent chance in the world is proportional to the inadequacy of our information.

(3) In a great variety of cases it seems better that events happen by chance (or, more properly speaking, with the appearance of chance) than according to any observable rule whatever. This is quite often the case even in human arrangements. Each person's place and precedency in a public meeting may be determined by lot. Work and labour may be settled by lot. '*Operumque laborem partibus equabat justis, aut sorte trahebat*' ['Work was divided equally, or assigned by lot' (Virgil).] Military service and rank may be settled by lot. The distribution of provisions may be made by lot (as in a sailors' mess) and in some cases so may the distribution of favours. In all these cases, it seems to be agreed that leaving events to chance has advantages superior to any that could arise from regulation. In all these cases also, though events rise up in the way of chance it is by appointment that they do so. [That sentence comes verbatim from the original.]

In other events—ones that are independent of human will—there seem to be still stronger reasons for regarding uncertainty as preferable to rule. For example, it seems to be expedient that the period of human life should be uncertain. If mortality followed any fixed rule, that would give to those who were at a distance from death a security that would lead to the greatest disorders; and give to those who were close to it a horror like what a condemned prisoner feels on the night before his execution. But for ·time of· death be uncertain, the young must sometimes die as well as the old. Also, if deaths were never sudden, people in good health would be too confident of life. The strong and active, who most need to be warned and checked, would live without apprehension or restraint. On the other hand, if sudden deaths were very frequent, the constant sense of jeopardy would interfere too much with the level of ease and enjoyment intended for us, and would make human life too precarious for the business and interests that belong to it. So the manner in which death is made to occur conduces to the purposes of admonition, without overthrowing the necessary stability of human affairs.

Because disease is the forerunner of death, there is the same reason for its attacks coming on us under the appearance of chance as there is for uncertainty in the time of death itself.

The seasons are a mixture of regularity and chance. [He devotes a paragraph to explaining why this is a good thing.]

Again, there are strong intelligible reasons why there should exist in human society great disparity of wealth and station; [see Glossary] not only as these are *acquired* in different degrees but from the start of life. For example: to meet the various demands of civil life there ought to be among the citizens a diversity of education that requires an original [see Glossary] diversity of circumstances. Since this sort of disparity that ought to take place from the beginning of life must be previous to the merit or demerit of the persons on whom it falls, can it be better disposed of than by chance? Parentage is that sort of chance; yet it is the commanding circumstance that generally fixes each man's place in civil life, along with everything relating to its distinctions. It may be the result of a beneficial rule that

> the father's fortunes or honours devolve on the son;

and, it seems, of a still more necessary rule that

> the low or laborious condition of the parent be communicated to his family;

but from the point of view of the successor himself it is the drawing of a ticket in a lottery. So inequalities of fortune (at least the greatest part of them, namely those that we have from birth and depend on our birth) can be left to chance, without any just cause for questioning the government of a supreme Disposer of events.

As for *acquired* civil advantages: it may be that they too ought in a considerable degree to be at the mercy of chance. Some people would like all the virtuous to be rich, or at least removed from the evils of poverty; presumably they do not notice that this would result in all the poor being wicked. How such a society could be kept in subjection to government has not been shown; for the poor—those who make their living by constant manual labour—must still form the mass of the community. If there were too few of them, the necessary labour of life could not be carried on, the work would not be done that the wants of mankind in a state of civilisation (and still more in a state of refinement) require to be done.

The demands of social life seem to call not only for an original diversity of external circumstances but for a mixture of different faculties, tastes, and tempers; and it is apparently expedient that these be promiscuously scattered among the different classes of society; so can the distribution of them be better made than by chance?

The opposites of apparent chance are **a** constancy and **b** perceptible interposition ·by God·; every degree of *secret* direction is consistent with apparent chance. Now, we have seen in some cases the inapplicability of **a** constancy, i.e. of fixed and known rules, and inconveniences that we do not see might attend their application in other cases.

As for **b** perceptible interposition: if Providence kept intervening in ways that were certainly distinguishable, that would be simply a situation where miracles were frequent and common. It is hard to judge what state this would throw us into. It is enough to say that it would be a total and radical change, which would deeply affect or perhaps subvert the whole conduct of human affairs. I can readily believe that such a state, with other circumstances being adapted to it, might be better than our present one. It may be the state of other beings; it may be ours hereafter. But the question we are now facing is: how far would it be consistent with our condition, supposing it in other respects to remain as it is? And there seem to be weighty reasons for answering 'Not very far'. For instance, so long as bodily labour continues for so many reasons to be necessary for the bulk of mankind, any dependence on supernatural aid might dislodge the motives that promote exertion or relax the habits that engender patient industry, thereby introducing negligence, inactivity and disorder into the most useful occupations of human life and thus worsening the condition of human life itself.

As moral agents we would experience a still greater alteration. I shall say more about this in the next section.

The Deity has the power to wind and turn as he pleases the causal chains that issue from himself, interposing to alter or intercept effects that would have taken place without such interposition. And it may very well be that he *does* do so, but that his over-all plans for us have led him to be secret about this. It is at any rate evident that a broad and full province remains for the exercise of Providence without its being naturally perceptible by us. You may say:

> The doctrine of divine Providence, because of the ambiguity [here = 'unclarity'] under which its exertions present themselves, can have no practical influence on our conduct; however firmly we believe that there is a Providence, we must prepare, provide and act as if there were none.

I answer that this is admitted. And I say further that preparing and providing in this way is consistent with the most perfect assurance of the reality of a Providence; and that it is, probably, one advantage of the present state of our information that our provisions and preparations are not disturbed by it. You may then ask:

> Of what use then is the doctrine, if it neither alters our measures nor regulates our conduct?

I answer again that it is of the greatest use, but that it is a doctrine of sentiment and piety, not (immediately at least) of action or conduct; that it applies to the consolation of men's minds, to their devotions, to arousing gratitude, supporting patience, keeping alive and strengthening every motive for trying to please our Maker; and that these are great uses.

Human life as a state of probation

[This section can be seen as a falling under the topic of the appearance of chance. It starts with a somewhat obscure repetition of the thesis that •the appearance of chance is consistent with •our being in the hands of a designing Creator, with one striking addition: 'It is undoubtedly true that •they may be reconcilable, though we cannot reconcile them.' Then Paley gets to the topic of the section:] The mind that contemplates the works of nature and sees in them so much counsel, intention and benevolence. can hardly turn its view to the condition of our own species without trying to suggest to itself some purpose, some design, for which the state we are placed in is fitted. I contend that the most probable supposition is that it is a state of moral probation [see Glossary], and that many things in it fit this hypothesis and fit no other. It is not a state of •unmixed happiness, or of •designed misery, or of •retribution. It fits none of these suppositions. It accords much better with the idea of its being

> a condition calculated for the production, exercise and improvement of moral qualities, with a view to a future state, in which these produced, exercised and improved qualities may in a new and more favouring constitution of things receive their reward or become their own reward.

If it be said that this introduces a religious rather than a philosophical consideration, I answer that the word 'religion' ought not to form an objection if it turns out to be the case that the more religious our views are the more probable they are. The degree of beneficence, benevolent intention and power exercised in the construction of sensitive beings tells strongly in favour not only of a creative care but of a *continuing* care, i.e. of a ruling Providence. The degree of chance that appears to prevail in the world has to be reconciled with this hypothesis. Now, it is one thing to maintain the doctrine of Providence *along with* that of a future state, and another thing *without* it. In my opinion the two doctrines must stand or fall together. On other principles more of this apparent chance may be accounted for than is generally supposed, but a future state makes all the difference; if it can be shown that the appearance of disorder is consistent with—or even in some respects promotes—the uses of life as a preparatory state, then so far as this hypothesis ·of a future state· can be accepted, the ground of the difficulty is done away.

·ACTIVE VIRTUES·

In the wide scale of human condition, if may be that all of its manifold diversities are relevant to the design here suggested. Virtue is infinitely various. There is no situation in which a rational being is placed—from that of the best-instructed Christian down to the condition of the roughest barbarian—that does not provide room for moral agency, for acquiring, exercising and displaying good and bad voluntary qualities. Health and sickness, enjoyment and suffering, riches and poverty, knowledge and ignorance, power and subjection, liberty and bondage, civilisation and barbarity, all have their offices and duties, all serve for the formation of character; for when we speak of a 'state of trial', it must be remembered that characters are not only •tried, proved or detected by circumstances, but are also •generated and formed by them. The best dispositions may exist under the most depressed and afflicted fortunes. A West Indian slave who amidst his wrongs retains his benevolence is someone whom I for my part regard as among the foremost of human candidates for the rewards of virtue. The kind master of such a slave—i.e. one who, in the exercise of an inordinate authority, somewhat postpones his own interest to his slave's comfort—is likewise a meritorious character; but still he is inferior to his slave. But all I am contending for is that these two destinies, opposite as they may be in every other respect, are both equally *trials*. This applies to every other condition, to the whole range of the scale, right down to its lowest extremity. Savages appear to us all alike; but it is because of the distance from which we view savage life that we do not perceive differences of character in it. I am sure that good and bad moral qualities are called into action as much in these inartificial [here = 'simple, relatively primitive'] societies as they are in polished life, and that they exist in the former in as great a variety as they do in the latter. At least it is certain that the good and ill treatment each individual meets with ·in such a simple society· depends more on the choice and voluntary conduct of those around him than it does or ought to do under regular civil institutions and the coercion of public laws. And up at the other end of the scale—the part occupied by people enjoying the benefits of learning, together with the lights of revelation—there also the advantage is all along probationary. The revelation of Christianity is not only a blessing but a trial.

If it is true that our ultimate or most permanent happiness will depend not on the temporary condition into which we are cast but on our behaviour in it, then the way various external circumstances are distributed among the individuals of the human species is a much more fit subject for chance than we usually take it to be. Rousseau writes: 'This life being a state of probation, it is immaterial what kind of trials we experience in it, provided they produce their effects.' Of two agents who stand indifferent to [Paley's phrase] the moral Governor of the universe, one may be exercised by riches, the other by poverty. The treatment of these two may appear to be very opposite, but in truth it is the same: different as their conditions are in many way, in one important respect there is no difference, namely that their conditions are alike *trials*; both have their duties and temptations, as arduous and dangerous in one case as in the other; so that if the final award follows the character, the original distribution of the circumstances under which that character is formed can be defended on principles not only of justice but of equality. So why should not mankind draw lots for their condition? They take the portion of faculties and opportunities that happen to have been given to them, but the outcome is governed by something that depends on themselves, namely their application of what they have received. No rule was followed—none was necessary—in dividing the talents; in rewarding the use of them the rule of the most correct justice was followed.

I have said that the appearance of casualness that attends the occurrences and events of life not only does not interfere with its uses as a state of probation but actually promotes them.

·PASSIVE VIRTUES·

Passive virtues—of all virtues the severest and most sublime, and perhaps of all virtues the most acceptable to the Deity—would obviously be excluded from a constitution in which happiness and misery regularly followed virtue and vice.

- Patience and composure under distress, affliction, and pain;
- steadfast keeping up of our confidence in God, and of our reliance on his final goodness, at a time when everything is adverse and discouraging; and
- a cordial desire for the happiness of others, even when we are deprived of our own;

these dispositions, which perhaps constitute the perfection of our moral nature, would not have found their proper office and object in a state of avowed retribution, in which endurance of evil would only be submission to punishment.

Again: one man's sufferings may be another man's trial. The family of a sick parent is a school of filial piety. The charities of domestic life and indeed all the social virtues are called out by distress. But if misery is to be the proper object of mitigation or of the benevolence that tries to relieve, it must be really or apparently *casual*. It is only on such sufferings that benevolence can operate. For if the only evils in the world were punishments, properly and intelligibly such, benevolence would only stand in the way of justice. Relative virtue presupposes not only the existence of evils but that evils at least appear to be misfortunes, i.e. the effects of apparent chance. So it may be in the furtherance of the scheme of probation that the evils of life are made to present themselves in that guise.

I have already observed [see page 97] that when we let in religious considerations we often let in light on the difficulties of nature. So in the fact now to be accounted for, the degree of happiness that we usually enjoy in this life may be better suited to a state of trial and probation than a higher degree would be. The truth is that we are too much delighted with the world rather than too little. Imperfect, broken, and precarious as our pleasures are, they are more than sufficient to attach us to the eager pursuit of them. A regard to a future state can hardly be kept up as things are. If we were designed therefore to be influenced by that regard, might not a more indulgent system—a higher, or more uninterrupted state of gratification—have interfered with that design?

27. Conclusion

Whenever the mind feels itself in danger of being confounded by variety, it is sure to rely on a few strong points or perhaps on a single instance. If we observe in any argument that hardly two minds fix on the same instance, the diversity of choice shows the strength of the argument, because it shows the number and competition of the examples. There is no subject in which it is so usual to dwell on select or single topics, because there is no subject whose latitude is so great, as that of *natural history applied to the proof of an intelligent Creator*. For my part, I take my stand on human anatomy. [He lists some of his examples.] The reader's memory will go back to these instances, as they are set forth in their places; there is not one that I do not think decisive; not one that is not strictly mechanical; nor have I read or heard of any solution of these appearances that in the smallest degree shakes the conclusion I build on them.

·WHAT IS THE POINT OF ALL THIS?·

Of most of those who read arguments to prove the existence of a God, it will be said that they come out where they went in, that they were never ignorant of this great truth, never doubted it; which raises the question: 'What is gained by researches from which no new opinion is learned and on the subject of which no proofs were needed?' I answer that investigation always provides two things in favour of even the most generally acknowledged doctrines (supposing them to be true), namely **stability** and **impression**. Occasions will arise that test the firmness of our most habitual opinions; and on these occasions it is enormously useful to feel our foundation, to find a support in •argument for what we had accepted on •authority.

And what is gained by research in the *stability* of our conclusion is also gained from it in *impression*. Physicians say that taking a medicine is very different from getting it into the constitution. Something like that holds for those great moral propositions that ought to form the directing principles of human conduct. It is one thing to assent to a proposition of this sort; a very different thing to have properly imbibed its influence. Here are two things that I believe to be true. **(a)** Almost every man has a particular train of thought that his mind glides into when it is at leisure from the impressions and ideas that occasionally arouse it. **(b)** This train of thought, more than anything else, determines the character. So it is of the utmost importance that this property of our constitution be well regulated. Now, what draws mental exercise into any particular channel is

- •frequent or continued meditation on a subject,
- •placing a subject in different points of view,
- •induction of particulars,
- •variety of examples,
- •applying principles to the solution of phenomena, and
- •dwelling on proofs and consequences.

It is by these means, at least, that we have any power over our thought. Now, I think it is safe to say that that if one train of thinking is more desirable than another, it is the one that looks at the phenomena of nature with a constant reference to a supreme intelligent Author. To make this the ruling, habitual sentiment of our minds is to lay the foundation for everything religious. When we have done that, the world becomes a temple and life itself one continued act of adoration. Whereas formerly God was seldom in our thoughts, we can now scarcely look on anything without perceiving its relation to him. We now have something very different from a mere assent to a verbal proposition about the existence of the Deity. This difference can more especially be perceived in the degree of admiration and awe with which the Divinity is regarded when represented to the understanding by its [i.e. the understanding's] own remarks, its own reflections, and its own reasonings, compared with what is aroused by anything said by others. [He sketches the conclusions of the opening chapters, concluding:] Therefore one mind has planned—or at least prescribed a general plan for—all these productions. One Being has been concerned in all.

Under this stupendous Being we live. Our happiness, our existence, is in his hands. All we expect must come from him.

Nor ought we to feel our situation insecure. In every portion of nature that we can see, we find attention bestowed on even the minutest arts. We have no reason to fear our being forgotten, overlooked, or neglected.

·Natural theology and revelation·

Proving the existence and character of the Deity facilitates the belief of the fundamental articles of revelation. It is a step to have it proved that there must be something in the world more than what we see. It is a further step to know that, among the invisible things of nature there must be an intelligent mind that is concerned in its production, order, and support. These points being assured to us by natural theology, we may well leave to revelation •the disclosure of many details that our researches cannot reach, respecting either the nature of this Being as the original cause of all things or his character and designs as a moral governor; and also •the more full confirmation of other important details that we are not entirely certain about, though they do not lie altogether beyond our reasonings and our probabilities. The true theist will be the first to listen to any credible communication of divine knowledge. Nothing he has learned from natural theology will lessen his desire for further instruction, or his disposition to receive it humbly and gratefully. He wishes for light; he rejoices in light. His inward veneration of this great Being will incline him to attend with the utmost seriousness not only to •all that can be discovered concerning him by researches into nature but to •all that is taught by a revelation that gives reasonable proof of having come from him.

·The resurrection of the human dead·

But of all the articles of revealed religion the one that gets the most help from the previous belief in a Deity ·based on natural theology· is the all-important one of the resurrection of the human dead. The thing might appear hopeless if we did not see a power at work adequate to the effect, a power guided by an intelligent will and penetrating the inmost recesses of all substance. I am far from justifying the opinion of those who ‘thought it a thing incredible that God should raise the dead’; but I admit that it is necessary first to be persuaded that there is a God to do so. This being thoroughly settled in our minds, there seems to be nothing in this process (concealed as we confess it to be) that needs to shock our belief. They who hold that the acts of the human mind depend on organisation, that the mind itself indeed *consists in* organisation, are supposed to find a greater difficulty than others do in admitting a transition by death to a new state of sentient existence, because the old organisation is apparently dissolved. But I do not see that even these people need to apprehend that resurrection is impossible; indeed, even on their hypothesis resurrection is comparable with some other operations that we know with certainty that the Deity is carrying on. [After talking about how plants and animals generate their offspring, with all the offspring’s qualities being determined by an inconceivably small material particle, Paley continues:] And this particle owes its constitution to a prior body; yet its organisation, though formed within and through and by a preceding organisation, is not corrupted by its corruption, or destroyed by its dissolution. On the contrary, it is sometimes extricated and developed by those very causes. Now, an economy that nature has adopted to transfer an organisation from one individual to another may have something analogous to it when the purpose is to transmit an organisation from one state of being to another state; and those who base thought on organisation may get from this analogy some help with their difficulties. Anything that transmits a similarity of organisation will serve their purpose, because even according to their own theory it may be the vehicle of consciousness, which carries identity and individuality along with it through all changes of form or of visible qualities. [He speaks of other transformations in nature, and concludes:] This analogy shows that the Deity can mould and fashion the parts of material nature so as to fulfil any purpose he is pleased to appoint.

·IMMATERIAL SUBSTANCES·

Those who attribute the operations of mind to a substance totally and essentially different from matter—

> and these operations, though affected by material causes, are certainly far removed from any properties of matter that we are acquainted with

—adopt what may be sounder reasoning and a better philosophy; and *they* do not need help from the considerations I have been presenting, or at least to the same degree ·as those who base mind on organisation·. But some persons cannot shake off an adherence to the analogies that the corporeal world is continually suggesting to their thoughts; and they will be helped by every consideration that manifests the extent of the intelligent power acting in nature, the fruitfulness of its resources, the variety, aptness and success of its means; most especially by every consideration that tends to show that in the translation of a conscious existence there is not—even in their own way of regarding it—anything greatly beyond or totally unlike what takes place in the small parts of the order of nature that are accessible to our observation.

If there are any who think that the narrowness and feebleness of the human faculties in our present state hardly fit with the high destinies the expectations of religion point out to us, I would only ask them whether anyone who saw a child two hours after its birth could suppose that it would ever come to understand fluxions!

On the whole: in everything regarding this awe-inspiring—but, as we trust, glorious—change, we have a wise and powerful Being on whom to rely for the choice and appointment of means adequate to the performance of any plan his goodness or his justice may have formed for the moral and accountable part of his terrestrial creation. That great office rests with him. Let it be our office to hope and to prepare, under a firm and settled persuasion that •living and dying we are his, that •life is passed in his constant presence, that •death resigns us to his merciful disposal.

THE END