Moonstruck

HOW LUNAR CYCLES AFFECT LIFE

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For Elizabeth and Helen

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PREFACE

> 'Tell me Silent Moon, what are you doing in the sky, Silent Moon?' Giacomo Leopardi (1798–1837).

> 'Beliefs . . . in an influence of the Moon on life on Earth . . . are by no means all moonshine.' H. Munro Fox, 1928.

As an introduction to possible effects of the Moon on living organisms, nothing could have been more effective for me than a memorable event that occurred during my undergraduate days. At that time the Student Biological Society of the University of Sheffield was fortunate enough to lure Professor (later Sir) Alister Hardy, a distinguished marine biologist from Oxford University, to deliver an invited lecture. Fully expecting a lecture on his research concerning ocean plankton, the Committee delegated to me, as an aspiring marine biologist, the task of delivering the vote of thanks to the speaker after his talk. Duly flattered, but apprehensive, a short refresher course on Hardy's pioneering studies of instrumentation for collecting ocean

plankton continuously from moving ships, and experiments on the nightly upwards migrations of plankton, seemed necessary for appropriate preparation. However, all was in vain when the eminent Professor began his lecture by announcing that he would not speak about marine plankton, but about what he called 'aerial plankton', based on research he had carried out a few years earlier when he was Professor of Zoology at the then University College of Hull. He delivered a fascinating lecture, discussing day and night collections of insects, captured in various weather conditions and states of the Moon, using tow nets that he had arranged to have attached to railway trains travelling between Hull and London. As a lesson in how to think on one's feet or, more appropriately, one's seat, it was a salutary experience as my pre-prepared vote of thanks began to crumble away. Needless to say, I heard some of the lecture and certainly began to appreciate that living organisms may be affected by the light of the Moon and not simply by light changes between day and night. Others, before and after that time, have considered whether or not aspects of the behaviour of animals are affected by the Moon and the question to be addressed in this book is the extent to which there is scientific evidence that the Moon has influenced living organisms, particularly animals, including humans, throughout the timescale of evolution.

* * *

We live in an age when the reality of the Moon has been studied intensively by remote-sensing from orbiting, man-made satellites, and by instruments that have been engineered

to soft-land on the Moon after rocket-propelled transport from Earth. Impressively, too, sophisticated gadgetry has been placed there by astronauts on Apollo missions. Contrast these events with perceptions of the Moon by early humans, for whom cyclical changes in the size, shape, and position of the Moon in the sky had mystical properties. Such properties were formalized in lunar myths and legends among citizens of societies worldwide, as in those of ancient Rome and Greece, who considered, for example, that sheep's wool and human hair grew more rapidly when the Moon was in the ascendant. From earliest times, such beliefs have persisted, even concerning god-like influences of the Moon on various aspects of life on Earth, beliefs that in some cases persist until the present day, not least in astrology. Yet juxtaposed alongside such beliefs have been the views of realistic sceptics, who deny the possibility of any linkages between life processes on Earth and changes in the appearance and position of the distant Moon. Indeed, matters relating to the Moon are so widely viewed with scepticism that some even question the veracity of the extensively televised lunar landings by American astronauts, proposing that they were no more than elaborate hoaxes.

The word 'lunacy' is embedded in the English language. On the one hand it implies linkages between some aspects of human behaviour and phases of the Moon but, on the other hand, it can be used to describe the 'lunatic' state of mind of individuals who postulate that such linkages do occur. Over many years, until the present day, a plethora of contrasting

'beliefs' and 'disbeliefs' have extended to so-called Moon-related phenomena in many aspects of life on Earth, no doubt partly fostered by the imagination and creativity of artists and writers throughout history. Accordingly, scepticism concerning Moon-related phenomena, arising from a long legacy of myths, legends, and artistic imagery, is deeply entrenched in the human psyche. Indeed, even the scientific study of Moon-related biological phenomena has been slow to develop, with scientists fearing ridicule at the prospect of entering the field. This is in spite of the fact that in recent decades biological adaptation to solar cycles is seen to be commonplace. It is widely recognized that animals and plants are able to continue with rhythmic behaviour approximately in phase with day and night even when they are isolated in constant conditions. It is understood that such behaviour is controlled by internal biological clocks of circadian periodicity, understanding that is reinforced by human experience of jet-lag during travel across time zones. There is good understanding, too, that humans possess internal circadian clocks, the timing of which can be disrupted, to the detriment of well-being and even health.

It has taken fifty years or so for the study of heritable circadian clockwork within the science of chronobiology to become fully accepted, but the molecular basis of the clockwork, in the form of identifiable clock genes, is now generally understood. It is also generally recognized that the clock genes are involved in the release of substances, such as melatonin and

cortisol, which mediate in the control of biological rhythms at the level of the whole organism. In humans, reliant as we are on manufactured clocks and watches, we are not always aware of our biological internal timing system, but we certainly become aware of it when it is disturbed by jet travel. At such times we also recognize that not all our physiological systems run on the same time. We may adjust our sleep patterns after some days in a new locality after extensive journeys east or west, but our digestive and cognitive systems may take a little longer to catch up.

Chronobiology is also sufficiently advanced now that the medical profession is coming to recognize the significance of our inner biological timing system. There is now acceptance that circadian clock disruption can lead to metabolic and behavioural problems such as obesity and depression, as well as to more commonly understood symptoms of jet-lag. There is also increasing acknowledgement that the efficacy of prescription medication may vary according to the time of ingestion or application. Accordingly, a related science of chronotherapeutics is emerging whereby the optimal times for drug application are being determined from basic knowledge of the human circadian clock system.

In contrast to our understanding of circadian biological rhythmicity, matching the solar day, our understanding of possible Moon-related—that is, circatidal and circalunar—biological rhythmicity has lagged seriously behind. Nowadays, however, cushioned by the fact that it has been scientifically

established that some living organisms have adapted to *indirect* effects of the Moon through its influence on tides, even *direct* biological effects in response to, or in anticipation of, changing moonlight are being characterized and gaining in acceptability. In this book I will discuss these newly emerging aspects of the science of chronobiology, with examples from plants, but particularly among animals, with reference also to supposed lunar influences on human behaviour, setting them against the mythologies attributed to the Moon throughout human history.

Repeatedly throughout history supposed Moon-related effects upon human life processes have been critically dismissed with understandable scepticism. Recently, however, evidence is building up, for a small number of animals, that clock genes related to the periodicities of the Moon and tides may be present in their genetic make-up alongside the more familiar circadian clock genes. If circatidal and circalunar genes are present within some living organisms, might they be more widespread in the genetic make-up of animals and plants, and even in humans? If they are, perhaps the search for Moon-related rhythms in humans should now gain more respectability. At least one very recent study indicates that humans may indeed be inherently responsive to moonlight in the determination of patterns of sleep, paving the way for further scientific enquiry into the relationship between the Moon and the human condition. Humans have obviously adapted to the patterns of the solar day; are we now seeing that, less obviously, they have

also adapted to the lunar day and month? If so should we at least remain open-minded that moonlight may have more of an impact on our lives than few in modern societies have previously been prepared to admit?

* * *

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Small superscript numbers in the text refer to the numbered list of References that follows the Glossary.

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1

MOON MYTHS AND LEGENDS

Curiosity about the changing faces of the Moon is deep in the human psyche and at various times in human history there have been many supposed links between lunar periodicity and the natural world.

Not least, there are long-established perceptions that aspects of human behaviour are influenced by the Moon, which, worldwide, has in the past been worshipped as a deity. In Roman times the Moon was deified through the Moon-goddesses Juno and Luna, based on earlier Greek manifestations, and was endowed with powers that influenced philosophical and scientific thinking. The Moon's influence was characterized in the writings of the Roman Stoic philosopher Seneca, who argued that the Moon existed to make humans feel good by measuring time and making corn grow in an orderly way.[1] He was one of many scientific philosophers of the time who had a good knowledge of the Moon and its movements around the Earth,

and was able to relate those movements to the occurrence of tides and eclipses. Perceived associations between the Moon and human behaviour are evident, too, in the writings of Tacitus, a century later, who stated that the Germans held their 'political' meetings during times of the full Moon or new Moon, regarded as times most favourable to start new initiatives. But the perceived association between the Moon and human lifestyle is much more pervasive than this, probably going back to the dawn of human thought.

It is believed that, even in Palaeolithic times, estimation of the passage of time during pregnancy was determined by observation of the lunar cycle, which approximated to the menstrual cycle. Some evidence for this comes from a French cave wall relief dated around 22,000 BC that has been interpreted as including a pregnancy calendar.[2] The image depicts a pregnant woman holding a crescent-shaped animal horn with thirteen notches, the approximate number of lunar months in the solar year (Fig. 1).

This is a highly subjective interpretation of an ancient artefact, but early rationalization of a year of thirteen lunar months survived in European peasant communities well beyond the end of the first millennium AD. It has even been suggested that lingering superstition of the number thirteen in modern times relates to inadvertent recollection that the thirteenth lunar month is the last, or death, month of the year.[3]

The repeated waxing and waning of the Moon no doubt gave rise to many beliefs among ancient civilizations, not least

Fig. 1. A cave wall relief, the Venus of Laussel, from the Dordogne region of France, dated around 22,000 BC. The pregnant woman holds an animal horn with 13 notches, interpreted today as a pregnancy calendar.

in relation to the Moon's influence on menstruation, birth, growth, ageing, and death. For many, the repetitive nature of the lunar cycle was perceived to be evidence of the divine nature of the Moon itself. As Robert Graves wrote in *The Greek Myths*:

> Time was first reckoned by lunations, and every important ceremony took place at a certain phase of the Moon. (i. 13)
>
> …the religious system of the Neolithic and Bronze Ages in Europe seems to have been remarkably homogeneous, being based on the same mystical relationship between the Moon-goddess and her sons (i. 11)

Indeed, perceptions of lunar deities were so entrenched in human thinking that, by the time of the Mesopotamian civilization of the third century BC, the Moon was considered to be the dominant sky god particularly concerned with the rhythms of life.[4] Relatedly, the Babylonian goddess Annit, superseded by Ishtar, was originally believed to rule the Moon. Subsequently, the imagined influence of a lunar deity was so widespread that it was conceptualized in pre-Greek and Asian societies as the Moon-goddess, Selene, whose influence persisted into the time of classical Greek culture. The Selene mantle was later assumed by Artemis, regarded by some as a nature goddess, particularly of forests and hills. Throughout the Greek world different cults endowed particular gods with different talents but, to many, Artemis was a major Olympian goddess who presided over crucial aspects of human life processes and rites of passage, including childbirth. The medicinal herb *Artemisia* (mugwort) was so named because it was used to try to induce delivery during the birth of a child.

Lunar influence on early societies was such that, from earliest human history, the passage of time was not only estimated by monthly cycles of the Moon, but annual solstices and equinoxes, which could not be determined exactly, were approximated to the nearest full or new Moon. Originally the year was divided into Moon cycles, hence 'months', rather than fractions of the solar year. However, even when it was later established, after astronomical observations, that the solar year consists of 364 days, with a few hours to spare, it was divided

into so-called Moon cycles. The number 364 conveniently divided into thirteen 'months', each of 28 days, numbers which became sacred. Significantly, too, the timing of the 28-day 'month' approximates to the timing of the menstrual cycle of women, enhancing the case for the Moon to be worshipped as a female goddess. This supposed linkage was challenged long ago by Aristotle, who attributed it to coincidence, but the approximate conformity was given some credence much later by none other than Charles Darwin. In his writings Darwin asked whether, since humans are descended from fish-like ancestors, the approximately 28-day feminine cycle might not be a vestige of the past when life depended on the tides and therefore on the Moon.[5] In fact the so-called 28-day 'month' is an artificial construct. As we shall see in Chapter 2, the interval between successive full Moons, seen at the same position in the sky, from the same place, is 29.5 days. This is the duration of the synodic or true lunar month, the observed pattern of lunations which ancient (and modern) observers on Earth were characteristically aware of. It differs from estimates that the mean period of the human menstrual cycle is 27.32 days, to the extent that though a single episode of a typical menstruation cycle might coincide with the day of a full Moon, subsequent episodes would regularly change phase in relation to the full Moon, until they coincided again some thirteen or fourteen months later.

The occasional coincidences of particular women's menstrual cycles with specific phases of the Moon may in the