
Jürgen Blunck

Solar System Moons

Discovery and Mythology

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 Springer

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Foreword

Springer is proud to be publishing Dr. Jürgen Blunck's last book, *Solar System Moons*, in the International Year of Astronomy 2009. Sadly, Dr. Blunck passed away during the copy-editing phase in summer 2008, leaving some technical questions on the manuscript unanswered. We have sought to complete the book as carefully as possible and would like to gratefully acknowledge the kind support of the author's wife, Mrs. Zofia Blunck.

Jürgen Blunck received his PhD in history at the University of Kiel in 1961. His last employment before he retired in 2000 was as librarian senior councilor at the Berlin State Library. In September 2002 he was nominated as a consulting member of the IAU Working Group on Planetary System Nomenclature (WGPSN). In his journal articles and book publications he focused on the history of planet cartography. He was the author of several books in English and German, namely "Mars and Its Satellites", "Götter in Planeten und Monden", "Der rote Planet im Kartenbild", "Wilhelm Beer – Genius der Astronomie und Ökonomie", and "Wie die Teufel den Mond schwärzten".

Dr. Blunck's last book, *Solar System Moons – Discovery and Mythology*, is an entertaining and educating work collecting in a concise format (he used to refer to it as a "manual") the astronomical facts on the discovery of the satellites and rings of the solar system planets and the mythological backgrounds of their names.

Tamara Biese and Ramon Khanna
Springer-Verlag, Heidelberg

Preface

In the history of modern astronomical research, the discoveries of the planetary satellites have, numerically speaking, represented (apart from the inflationary increase in known minor planets) its greatest success. This is due to the space probes that have been sent into the outer solar system in recent decades, as well as (and particularly) advances in CCD technology, which have made it possible to detect satellites that are as small as a kilometer in size. Fifty years ago, in order of the sequence of planetary orbits beyond the Earth's orbit, two satellites of Mars, eleven satellites of Jupiter, eight satellites of Saturn, five satellites of Uranus and two satellites of Neptune were known. By the year 2007, this number of known satellites had grown dramatically: besides the two Martian satellites, 63 satellites of Jupiter, 62 satellites of Saturn, 14 satellites of Uranus, 13 satellites of Neptune, and four satellites of the former planet Pluto—which was downgraded to a “dwarf planet” by the General Assembly of the International Astronomical Union in Prague in 2006—had been discovered. This “downgrading” also happened to the newly discovered Pluto-like object named Eris, a dwarf planet with one known satellite.

Now that satellites only a kilometer across have been found, it is natural to consider the definition of a satellite. The term “satellite” was first used by Johannes Kepler in his pamphlet *Narratio de Iovis Satellitibus*, Frankfurt 1611. Officially, a satellite is a solid object in orbit around a planet, dwarf planet, minor planet or trans-Neptunian object. A natural satellite is sometimes referred to as a “moon” in popular usage. However, Earth's own satellite is called “the Moon” in both scientific and popular speech. All satellites are designated with Roman numerals and a name. Of course, this does not resolve the question of how big a body must be to be classified as a “satellite.” A satellite smaller than one kilometer across has not yet been discovered, and it is not clear whether such small satellites would be given proper names.

The naming of a satellite occurs in parallel with its discovery, although it can sometimes be a lengthy procedure. Satellite baptism was and still is the indisputable right of the discoverer, who voluntarily only proposes names that are in line with the names of previously discovered satellites of the (dwarf) planet around which the newly discovered satellite orbits.

Two exceptions have been made during the history of satellite designation. First, the initial seven satellites of Saturn were named by William Herschel's son John, after the initial use of numbers alone to denote them caused confusion. It was also John Herschel who in 1851 named four hitherto unnamed satellites of Uranus. Second, all of the satellites of Jupiter discovered between 1892 and 1974, which had remained unnamed according to the explicit wishes of the discoverers, were nevertheless assigned names by the International Astronomical Union in 1975; these names were figures from the court of Jupiter/Jupiter in Greco-Roman mythology.

From 1919 onwards, the responsibility for deciding upon satellite names rested upon the shoulders of the International Astronomical Union, before this responsi-

bility was shifted in 1973 to a special Working Group for Planetary System Nomenclature (WGPSN).

The steps involved in naming a newly discovered object accompanying a planet are fixed according to international guidelines. The object is reported by the discoverer to the Central Bureau for Astronomical Telegrams (CBAT) in Cambridge, MA, USA, and it then receives a temporary designation, such as S/2007 S1 for a satellite of Saturn or R/2004 S1 for a ring of Saturn. Having been designated in this way, the object is announced in the IAU Circulars, a series of postcard-sized announcements.

Names for newly discovered satellites are developed jointly by the WGPSN and the IAU Commission 20 (Positions and Motions of Minor Planets, Comets and Satellites). Names are not assigned to satellites until their orbital elements are reasonably well known. As soon as the new satellite is confirmed (e.g., by rediscovery), the discoverer suggests a name that is then discussed by the WGPSN; in this case initially by its Outer Solar System Task Group and then by its other members. This panel reports directly to the IAU's Executive Committee, after which its recommendations are approved by the General Assembly, which meets every three years.

Greco-Roman names dominate satellite nomenclature, and the Roman version prevails among Greco-Roman names.

The rules for naming the satellites of Saturn changed somewhat in 2000. The many irregular satellites discovered in that year were grouped after their semi-major axes, their inclinations and their eccentricities, and they received names from other languages, mainly the names of giants. An Inuit group, a Gallic group and a Norse group were suggested by the discoverers and adopted by the International Astronomical Union. The myths of the relevant peoples and even characters from children books were used to name these satellites.

This manual contains chronological overviews of the discoveries of satellites and rings, background information on how they were named, and also selections from the sources from which the names of the satellites originated. Finally, plates containing data on the orbital elements and discoveries of the satellites are provided.

Further information on the planetary satellites, especially the names of their many topographic surface features, is available on the Internet (see the *Gazetteer of Planetary Nomenclature*).

The satellites of minor planets are not taken into account in this manual.

Berlin, January 2008

Jürgen Blunck

Contents

The Satellites and Rings of the Planets

The Satellites of Mars	3
Discovering and Naming the Satellites	4
Sources of Satellite Names	5
The Satellites of Jupiter	7
The Satellites and Rings of Jupiter	8
Discovering and Naming the Satellites	8
Discovering and Naming the Rings	19
Sources of Satellite Names	20
The Satellites of Saturn	53
The Satellites and Rings of Saturn	54
Discovering and Naming the Satellites	54
Discovering and Naming the Rings	62
Sources of Satellite Names	66
The Satellites of Uranus	91
The Satellites and Rings of Uranus	92
Discovering and Naming the Satellites	92
Discovering and Naming the Rings	95
Sources of Satellite Names	98
The Satellites of Neptune	111
The Satellites and Rings of Neptune	112
Discovering and Naming the Satellites	112
Discovering and Naming the Rings	115
Sources of Satellite Names	116

The Satellites of the Dwarf Planets

The Satellites of Pluto	127
Discovering and Naming the Satellites	128
Sources of Satellite Names	129

The Satellite of Eris	133
Discovering and Naming the Satellite	134
Source of the Satellite Name	135
References	137
Index of Satellites	139

The Satellites and Rings of the Planets

Photograph on opposite page: Mars and the tiny Phobos and Deimos, photographed by James McGaha on August 29, 2003, using a ToUcam on a 36-inch reflector atop Kitt Peak

The Satellites of Mars



The Satellites of Mars

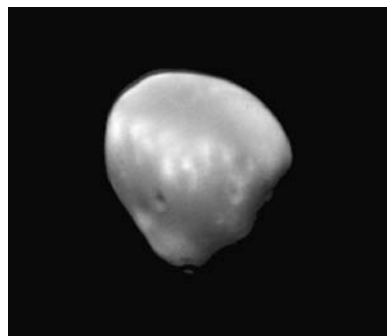
Discovering and Naming the Satellites

It was Johannes Kepler (1571–1630) who first predicted the existence of two satellites of Mars. In 1611 he misinterpreted an anagram by Galilei concerning Saturn as the announcement of Martian satellites: “Be greeted, double knob, children of Mars.” Based on numerological arguments, he also noted that it seemed to him quite probable that Mars had two companions, since Mars orbits between Earth—a planet with one moon—and Jupiter, a planet with (at that time) four known moons.

In 1726, Jonathan Swift (1667–1745), master of English satire, published the novel *Gulliver’s Travels*. In book 3, chapter 3 he described two satellites of Mars, giving relatively accurate values for their orbital parameters: he stated that Phobos is 13,600 (actually 6000) km from the surface of Mars and that this moon orbits Mars in 10 (actually 7.7) hours, while he said that Deimos is 27,200 (actually 20,100) km from Mars and that it has an orbital period of 21.5 (actually 30.3) hours. Swift was obviously familiar with Kepler’s three laws of planetary motion. Swift’s description of the Martian satellites influenced, among others, François Marie Arouet Voltaire (1694–1778), who describes two small satellites of Mars in his philosophical work of fiction *Micromégas* (1752), also as astronomical research. The systematic search for Martian satellites performed by Johann Heinrich Mädler in Berlin in 1830 and by Heinrich Louis d’Arrest in Copenhagen in 1864 using telescopes was hopeless. It was necessary to wait for Mars to reach opposition at perihelion in 1877.



Phobos; image taken on 22 August 2004 by the HRSC (High-Resolution Stereo Camera) on Mars Express at a distance of less than 200 km. Copyright ESA/DLR/FU Berlin, G. Neukum



Deimos image taken on 10 July 2006 with the Mars Orbiter Camera (narrow angle) on Mars Global Surveyor at a distance of 22,985 km. Copyright ESA/DLR/FU Berlin, G. Neukum

On August 11, 1877, after many nights of searching in vain for satellites fueled by the encouragement of his wife Angeline, Asaph Hall finally succeeded in finding a faint object on the following (eastern) side and a little north of the planet using the 26-inch Clark refractor at the US Observatory in Washington DC. The “faint object” was the outer satellite. Hall discovered the inner moon on August 17. Measurements were made of these objects on August 18, which were then recorded as the “Mars satellites” (1878, *Monthly Notices*, 38, 205).

The two natural satellites were named by Asaph Hall after the two comrades of Mars, Deimos (Fear) and Phobos (Flight). In his *Observations and Orbits of the Satellites of Mars* (1878, US Govt., Washington), Hall writes:

Of the various names that have been proposed for these satellites, I have chosen those suggested by Mr. Madan of Eton, England [Henry Madan (1838–1901), Science Master of Eton College], viz: Deimos for the outer satellite; Phobos for the inner satellite. These are generally the names of the horses that drew the chariot of Mars; but in the lines referred to they are personified by Homer, and mean the attendants, or sons of Mars. These lines occur in the Fifteenth Book of the *Iliad* (line 119), where Ares is preparing to descend to the earth to avenge the death of his son. Bryant’s translation is as follows: “He spoke, and summoned Fear and Flight to yoke His steeds, and put his glorious armor on.”

The two fearful figures attending the warriors were not just servants of Ares; they were his sons (*Iliad* 13,299; Hesiod, *Theogony* 933), and consequently independent deities (and unambiguously described thus by Plutarchus). They were only represented as steeds by Antimachus (frg. 35), who misinterpreted the quotation from Homer mentioned above. The names were originally used by Hall in a latinized version, i.e., Deimus, Phobus (1878, *Astronomische Nachrichten*, 92, 2187).

Latin versions of Greek names are common among the nomenclature of the Solar System; however, there are no consistent Latin translations of Deimos and Phobos. The Romans called Deimos Pallor (Livy), Terror (Ovid), or Formido (Claudianus), while Phobos was mostly known as Pavor.

Sources of Satellite Names

Mars I PHOBOS (Φοβος; “Panic”, “Rout”)

Mars II DEIMOS (Δειμος; “Fear”)

Hesiodus: Theogony 933 (932–937):

Also Cythera [Aphrodite] bare to Ares the shield-piercer Phobos [Panic] and Deimos [Fear], terrible gods who drive in disorder the close ranks of men in numbing war, with the help of Ares, sacker of towns; and Harmonia whom high-spirited Cadmus made his wife.

Homerus: Iliad 13,299 (298–300):

And even as Ares, the bane of mortals, goes forth to war, and with him follows Phobos [Panic], his son, valiant alike and fearless, that turns to flight a warrior ...

Homerus: Iliad 15,119 (113–120):

(The Olympic gods are talking about the course of the Trojan War:)

but Ares smote his sturdy thighs with the flat of his hands, and with wailing spake, and said: "Count it not blame for me now, O ye that have dwellings on Olympus, if I go to the ships of the Achaeans and avenge the slaying of my son [Askalaphos of Orchomenos], even though it may be my fate to be smitten with the bolt of Zeus, and to lie low in blood and dust amid the dead."

So spake he and bade Deimos [Terror] and Phobos [Rout] yoke his horses, and himself did on his gleaming armour.

**Plutarchus: Theseus 27,2:**

For a long time there was hesitate and along on both sides in making the attack, Theseus, after sacrificing To Phobos [Fear], in obedience to an oracle, joined battle with the women [Amazons].

Plutarchus: Alexander 31,5:

Alexander, while his Macedonians slept, himself passed the night in front of his tent with his seer Aristander, celebrating certain mysterious rites and sacrificing to the god Phobos [Fear].

Photograph on opposite page: Jupiter and its satellites (from above: Io, Europa, Ganymede, Callisto). Copyright NASA

The Satellites of Jupiter



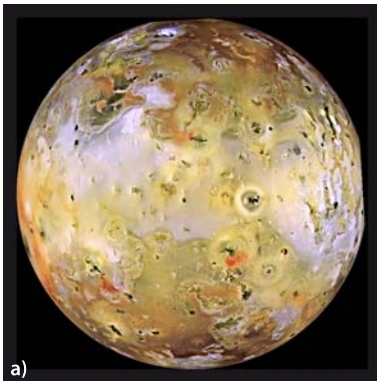
The Satellites and Rings of Jupiter

Discovering and Naming the Satellites

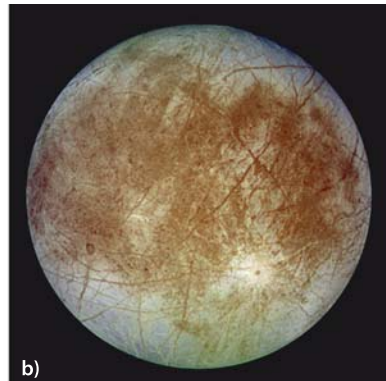
In March 1610 in Venice, Galilei Galileo published a small book entitled *Sidereus Nuncius* (*Message of the Stars*), declaring on the title page that he was “revealing great, unusual, and remarkable spectacles . . . above all in FOUR PLANETS swiftly revolving about Jupiter at differing distances and periods, and known to no one before the Author recently perceived them and decided that they should be named MEDICEA SIDERA (‘the Medicean Stars’).”

The telescope he had built himself and used in Padua to make his discoveries since January 7, 1610 was a 30 power refracting telescope with a tube 60 cm long.

The first astronomer to observe these satellites, however, was Simon Marius (1570–1624) in Nuremberg (Oudemans JAC, Bosscha J, 1903, “Galilée et Marius,” in: *Archives Néerlandaises des Sciences Exactes Naturelles*, Ser. 2, 8, 115–189), but he did not publish his discoveries until 1614 in a book entitled *Mundus Jovialis Anno 1609 Detectus*, in which he claimed that he rebuilt a Dutch telescope and then used it to observe Jupiter’s moons from late November 1609 onwards; he began to record his observations on December 29. (Note that he was actually using the Julian calendar, and this date corresponds to January 8 on the Gregorian calendar.) While Galilei had named the moons after the dynasty of the Grand Duke Cosmo de’ Medici II of Tuscany (since the discoveries were made under his auspices), Marius proposed mythological names in his book. The following extract was translated from the Latin by Samuel G. Barton (1946, “The names of the satellites,” in: *Popular Astronomy*, 54, 125):



a Image of Io taken by a camera on the Galileo spacecraft in September 1996. Copyright NASA/JPL/University of Arizona



b Galileo image of the trailing hemisphere of Europa, taken in natural color in July 1996. Copyright NASA

Perhaps, however, there will be some who will (...) demand from astronomers a name for these four satellites of Jupiter that will be appropriate to each and every one of them. I think that these persons can actually be satisfied in this respect (...) Jupiter especially is charged by the poets with illicit loves. Especially well known among these are three virgins, whose love Jupiter secretly coveted and obtained, namely: Io, the daughter of the river god Inachus, then Callisto daughter of Lycaon, and finally Europa, the daughter of Agenor. Yet even more ardently did he love the beautiful boy Ganymede, son of the king of Troy, to the extent that, having assumed the form of an eagle, he placed him on his shoulders and transported him to heaven (Olympus) according to the tale told by the poets, especially by Ovid in book 10 fable 16 (*Metamorphoses* 10, 143–161). And so I believe I have not done badly in naming the first Io, the second Europa, the third, on account of the splendor of its light, Ganymede, and lastly the fourth Callisto. The names are comprised in the following distich:

*Io, Europa, Ganimedes puer, atque Calisto.
Lascivo nimium perplacuere Jovi.*

(Io, Europa, the boy Ganymede, and likewise Callisto aroused to excess the lust of Jove.)

Mr. Kepler, the Imperial Mathematician, presented the opportunity for this fanciful application of names when we were together at a meeting in Ratisbon (Regensburg), in October, 1613. Therefore, if I hail him as the co-sponsor of these four stars as a result of a jocular fantasy and of the friendship begun between us at that time, I shall not have done badly.

But all of these names have been freely imagined by me, so let everyone feel free either to reject or accept them.

These names subsequently became generally known among astronomers, but they made little use of them. A frequently used alternative was to designate the satellites individually by the numbers one to four in order of their distance from Jupiter. Galilei himself began to use these designations around January 1610. The title “Galilean satellites” was probably first used for all four bright Jovian moons by the Greenwich astronomer W.T. Lynn (1835–1911) in 1892 (*The Observatory*, 15, 429).

The first moon to be discovered after the discovery of the Galilean satellites in 1610 was detected on September 9, 1892 by Edward Emerson Barnard while he made observations from the Lick Observatory on Mount Hamilton with a 36-inch (91 cm) refractor telescope.

The discoverer hesitated to name this fifth satellite of Jupiter due to “an increasing tendency to recognize the names for the four which were proposed by Marius.” It was the W.T. Lynn stated that this tendency was regrettable in an article published in 1892 (*The Observatory*, 15, 427), because Marius claimed to have made his discovery before Galilei. This happened eleven years before Oudemans and Bosscha produced evidence of the truth of Marius’ claim. Lynn also made reference to the fact that two of Marius’ names, Io and Europa, had already been introduced as names of asteroids.

He pointed out that Jupiter is associated with the thunderbolt, and concluded (1892, *The Observatory*, 15, 429):

My suggestion, then, offered in all diffidence, is that the Galilean stellites be still called, as formerly, by their numbers I., II., III., IV. (now used in so many books that they have almost become names in this connection), and that the new interior one be designated Fulmen, or (if a Greek form be preferred, as in the case of the satellites of Mars) Keraunos.

A more meaningful and suitable suggestion was published by the French astronomer Camille Flammarion (1893, *L'Astronomie*, 12, 94):

Le jeune Jupiter fut alors caché dans l'île de Crète, sur le mont Ida, où il fut nourri du lait de la chèvre Amalthée, pour les soins des nymphes Ida et Adrastée.

Nous soumettons donc à M. Barnard l'idée suivante: Pourquoi ne pas choisir le nom de cette nourrice assez originale? *Amalthée* n'est pas vilain. On pourrait aussi penser à la nymphe Ida. Mais la montagne aussi s'appelait Ida.

Amalthée se présente en première ligne, comme petite nourrice du dieu suprême. Son nom, il est vrai, a été donné à une petite planète, comme aux d'Europe et d'Io; mais (...) il ne peut y avoir de confusion entre les observations d'une satellite de Jupiter et celles d'une petite planète.

Edward E. Barnard answered (1893, *Popular Astronomy*, 1, 81–82):

So far this satellite has not received any name, although many names have been suggested for it. Most of these are mythological and have some connection with Jupiter. Columbia, on account of the satellite being found in the Columbian year, and Eureka, because of California, the state in which it was discovered [*Eureka*, the exclamation of Archimedes, is the motto of the State of California], have been suggested. It would seem, however, almost to have found itself a name—'The Fifth Satellite.'



Galileo image of Ganymede taken on 10 June, 1996. Copyright NASA/JPL

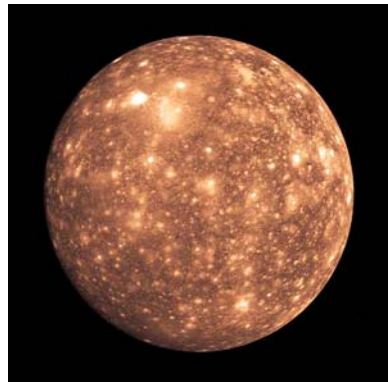


Image of Callisto taken by Voyager on July 7, 1979. Copyright NASA/JPL

In astronomical literature there is a strong tendency to call it simply 'The Fifth Satellite' as it was called in the announcement of discovery. There is some opposition to this, as it might be misleading. The other satellites of the giant planet, besides their mythological names, are also designated as I, II, III, IV, with the Roman numerals, in order of their distance from Jupiter. If now the new one is called V it would imply that it is the most distant of the satellites, while in reality it is the nearest of all to the planet, and ought by all means, according to this method of numeration, to be Satellite I, which would necessitate a renumbering of the satellite system. I would say, also, in this connection, that the celebrated French astronomer, Camille Flammarion, has written, suggesting the name Amalthea, the nurse of Jupiter (the smallness of the satellite would make this name rather inappropriate), and giving various reasons why it should be so called.

The most that can be said at present is that it is yet nameless, and may so remain. The mythological names of the four older satellites are seldom used. It may be necessary, however, to give a mythological name to prevent confusion.

In July 1894, Barnard confirmed his opinion (*Astronomical Journal*, 14, 97):

The numerals, to me at least, stand as names, and do not necessarily have any bearing on the relative distances of the satellites. It would be dangerous and absurd to change the present notation to introduce the new satellite as I, and it would be equally absurd to call it 0, as some have suggested, for we cannot tell what development the great telescopes of the future may bring about in the Jovian satellite-system.

I think, therefore, that this new moon should continue to be called the 'Fifth Satellite,' or Satellite V, as I have always called it. This will also be correct if we assume the other satellites were numbered in the order of their discovery, which can be done without violating the facts.

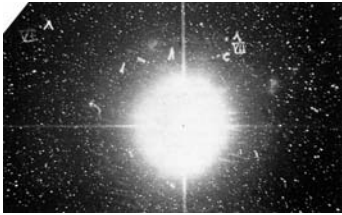
There is certainly nothing to be gained by giving this object a special mythological name. However, if it is the general desire of astronomers that it should bear such a name, I will select one for it.

The other satellites of the solar system (except that of Neptune) are suitably named and those names have come into regular use. Why not let the magnificent Jovian system differ from all the rest by a different order of nomenclature.

On December 3, 1904, Jupiter VI was discovered by Charles Dillon Perrine in photographs taken with the Crossley 36-inch (0.9 meter) reflector of the Lick Observatory on Mount Hamilton at the University of California, San Jose. Jupiter VII was also discovered there by Perrine on January 5, 1905.

A call for full names for the new satellites VI and VII was published by the British astronomer Andrew Claude de la Cherois Crommelin in March 1905 in his article "Provisional elements of Jupiter's satellite VI" (*Monthly Notices of the Royal Astronomical Society*, 65, 5, 526–527):

Unfortunately the numeration of Jupiter's satellites is now in precisely the same confusion as that of Saturn's system was before the numbers were abandoned



The Jovian satellites VI (Himalia) and VII (Elara), from observations made by Max Wolf at the Waltz reflector of the Landessternwarte Heidelberg-Königsstuhl on December 23, 1906. Exposure time was 90 minutes; the guidestar was V Cas. The traces for the satellites were marked by Wolf himself. (From the Archives of the Landessternwarte Heidelberg-Königsstuhl)



Himalia, captured and resolved in a series of narrow angle images taken by the Cassini spacecraft camera on December 19, 2000. Copyright NASA/JPL/University of Arizona

and names substituted. A similar course would seem to be advisable here; the designation V. for the inner satellite was tolerated for a time, as it was considered to be in a class by itself; but it has now got companions, so that this subterfuge disappears. The substitution of names for numerals is certainly more poetic and abbreviations may be devised which would take no more space in printing than the present notation (e.g. Io, Eu., Gan., Cal. for the four old satellites).

This call was ignored once more when, on January 27, 1908, Jupiter VIII was discovered by Philibert Jacques Melotte with the 30-inch Cassegrain reflector of the Greenwich Observatory.

On July 21, 1914, Jupiter IX was discovered by Seth Barnes Nicholson on photographic plates taken with the 36-inch (0.9 meter) reflector of the Lick Observatory on Mount Hamilton. On July 6, 1938, he also discovered Jupiter X, but this time with the 100-inch (2.5 meter) Hooker telescope at Mount Wilson, Carnegie Institution. On July 30, 1938, Jupiter XI was also discovered by Nicholson with the 100-inch telescope on Mount Wilson. Nicholson himself declined to propose names for his discoveries. In an article from March 1939, "The satellites of Jupiter" (*Publications of the Astronomical Society of the Pacific*, 51, 300, 93–94), he writes:

Many have asked what the new satellites are to be named. They will be known only by the numbers X and XI, written in Roman numerals and usually prefixed by the letters J to identify them with Jupiter. The four satellites discovered by Galileo were once named but they are commonly referred to as satellites I, II, III, and IV than by their names, Io, Europa, Ganymede, and Callisto. (...) When Barnard discovered the fifth satellite of Jupiter many names were proposed for it but none was adopted. Barnard thought that, since the names of the four bright satellites were so little used, the new satellite should simply be called the Fifth

Satellite. His suggestion was followed and a similar custom has prevailed for all those discovered since. This is a very convenient custom, especially since so many have been found, which makes it possible to foretell the name of the next, if another should be discovered. It will be J XII.

It was Nicholson again who spotted the faint image of J XII on a routine photograph of Jupiter made with the 100-inch (2.5 meter) Hooker telescope of the Hale Observatories on Mount Wilson on September 28, 1951.

New attempts to designate the many known Jovian satellites which remained unnamed according to the wishes of their discoverers were made in 1955 by Brian G. Marsden (*Journal of the British Astronomical Association*, 65, 308–310), in 1962 by E.I. Nesterovich (*Bulletin of VAGO/Astronomical-Geodetical Society of the U.S.S.R.*, 31, 38, 51–56), and in 1973 by Yuri A. Karpenko (*Zemlya i Vselennaya*, 6, 55–58). Their lists each contained the same five unofficial names that were in use for J I to J V (Io, Europa, Ganymede, Callisto). Marsden also suggested the names VI Hestia, VII Hera, VIII Poseidon, IX Hades, X Demeter, XI Pan, and XII Adrastea; Nesterovich the names VI Atlas, VII Hercules, VIII Persephone, IX Cerberus, X Prometheus, XI Dedalus, and XII Hephaestus; and Karpenko the names VI Adrastea, VII Ida, VIII Helen, IX Leda, X Latona, XI Danae, and XII Semele.

The selections of Karpenko are worth noting, since the names proposed for J VI and VII are connected to the name for J V, since Amalthea, Adrastea and Ida all are the nurses of Zeus. The names for J IX to XII are prominent lovers of Zeus, like Io, Europa and Callisto. Helen, the daughter of Zeus and Leda, is inserted between the nurses and the lovers of Zeus. But neither this list nor the other lists met with enthusiastic receptions.

The thirteenth moon was discovered by Charles Thomas Kowal on plates taken from September 11 through 13, 1974, with the 122-cm Schmidt telescope at Mount Palomar. Further observations and calculations confirmed the existence of Jupiter XIII. Like Nicholson (1891–1963), the discoverer expressed a preference for the use of a number as designation for his discovery, which was the sixth satellite in the sequence of increasing distance from Jupiter: J V or Amalthea (unofficial), J I or Io (unofficial), J II or Europa (unofficial), J III or Ganymede (unofficial), J IV or Callisto (unofficial), J XIII, J VI, J VII, J X, J XII, J XI, J VIII, J IX. The IAU Working Group for Planetary System Nomenclature, however, decided to legalize the unofficial names Amalthea, Io, Europa, Ganymede, and Callisto, and to give names to the other nameless satellites. On its recommendation, a list of proposed names was approved on October 7, 1975 by the IAU Executive Committee. Even then, Charles T. Kowal tried to prevent the acceptance of names by the IAU members. In 1976, he published his “case against names” (*Icarus*, 29, 513):

I share the belief that the satellites should not be named, for I feel that names would be useless, superfluous, and potentially confusing.

Certainly, mythological names have no practical value. A designation such as ‘J XIII’ unambiguously identifies the object as a satellite of Jupiter, while the name ‘Leda’ does not. (...) Would anyone consider giving a name to every day of the year?

Nevertheless, in August 1976 the 16th General Assembly in Grenoble accepted the following Resolution V concerning outer solar system nomenclature:

1. The names of new satellites should follow the traditions established by the existing names for satellites in a given system.
2. Within this guideline the discoverer of a new satellite should be free to choose the name for his discovery.
3. In the case of Jupiter, there are now many reasons for applying names to the satellites that presently only have numbers. Following the rule given in V 1 above, we propose the following names:

The innermost satellite

J V Amalthea

The outer satellites

J VI	Himalia	J VIII	Pasiphae
J VII	Elara	J IX	Sinope
J X	Lysithea	J XI	Carme
J XIII	Leda	J XII	Ananke

The left hand column contains satellites with *direct* orbits, and names ending in “a”. The right hand column contains satellites with retrograde orbits, and names ending in “e”. The name “Leda” was proposed by the discoverer of J XIII, Dr. Charles Kowal. (The tradition of using only numbers for J V–J XII stems from Barnard’s discovery of J V at a time when even J I–J IV were formally only recognized by number. This tradition is now out of favor, and at least two informal name systems are in use in some places. We also face the possible embarrassment of naming features on an unnamed object. It therefore seems necessary to name these satellites. Dr. Kowal has expressed a preference for using only numbers—his choice of “Leda” was offered if we decided to name all the satellites. Since this was our decision, we have now accepted his suggested name.)

4. In anticipation of the discovery of surface features on the satellites of Jupiter and Saturn, we proposed to use the mythologies of various cultures as sources of names for such features. We can use epics from a given mythology to provide a natural association for names of various types of features in a given area or a given satellite. We also propose to use words from Esperanto to name features on some of the smaller satellites.

In *Icarus*, the Chair of the Outer Solar System’s Task Group of the Working Group for Planetary System Nomenclature, Tobias Owen, explained the new Jovian satellite nomenclature (1976, *Icarus*, 29, 160):

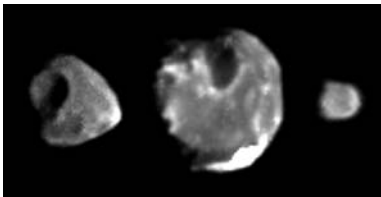
Our two guiding principles were to adhere to tradition and to avoid duplication with existing names, as much as possible. The qualifier is necessary because the

asteroids, as will be seen. (...) It has become customary to distinguish between the regular (J I–V) and irregular (J VI–XIII) satellites, the latter group having high orbital inclinations and eccentricities. It would be helpful to embody this distinction in the names, if possible. We were greatly aided in our task by a proposal (of names that have not yet be applied to any solar system objects). This subset is sufficiently diverse to permit the establishment of a simple mnemonic device for the irregular satellites, distinguishing between those having direct and those having retrograde orbits by using names ending in -a and -e, respectively.

This proposal struck us as a very useful and appropriate scheme for providing the names we needed. We felt, however, that we should not categorically exclude names already in use for asteroids; we should simply do our best to avoid such duplication in order to minimize confusion, both now and in the future, when the satellites and the asteroids are likely to receive additional study including investigative visits from space probes. Thus the proposal by C.T. Kowal that J XIII, the satellite he had just discovered, should be named Leda was unanimously accepted, despite the fact that an asteroid already carries that name. Similarly, it was felt that we should legitimize the widespread use of Amalthea for J V; the goat nymph who acted the part of Jove's nurse seems an appropriate choice for the closest satellite, although we again duplicate the name of an asteroid. Indeed, there are asteroids named Io (85), Europa (52), Ganymede (1036), and Callisto (204) also.

Three additional inner satellites of Jupiter, two orbiting within the orbit and one outside the orbit of Amalthea, were discovered on images obtained from the cameras of the Voyager 1 and 2 spacecraft, which were both launched in 1977. The innermost satellite was discovered on March 4, 1979 by Stephen B. Synnott in images from the Voyager 1 probe and provisionally designated S/1979 J 3. The outermost inner satellite, orbiting between Amalthea and Io, was also discovered by S.B. Synnott on March 5, 1979 in images from the Voyager 1 probe taken on the same day, and was initially given the provisional designation S/1979 J 2. Later it was found on images dating back to February 27, 1979.

The satellite orbiting between the innermost satellite and Amalthea was discovered on July 8, 1979 by David C. Jewitt and G. Edward Danielson in images from the Voyager 2 probe, and received the provisional designation S/1979 J 1.



High-resolution images of the three inner Jovian satellites Thebe, Amalthea and Metis, taken in January 2000 by a camera on the Galileo spacecraft. Copyright NASA Jet Propulsion Laboratory (NASA-JPL)

The Working Group for Planetary System Nomenclature gave S/1979 J 1 the name Jupiter XV Adrastea, after one of the three sisters of Amalthea and the nurses of the child Zeus, S/1979 J 2 became Jupiter XIV Thebe after a nymph and lover of Zeus, and S/1979 J 3 was designated Jupiter XVI Metis after the first wife of Zeus. Two of the three new inner satellites, which all follow prograde orbits, received an exception from resolution V regarding names ending in “a.” The three names were approved in August 1982 by the 18th IAU General Assembly in Patras, Greece (*Transactions of the IAU*, XVIII A, 669; *note*: the numbers of J XIV and J XV are erroneously exchanged, but were corrected by the IAU Executive Committee on September 30, 1983: *IAU Circular* 3872).

An unusual prograde irregular satellite was first discovered by Charles T. Kowal and Elizabeth Roemer on September 30, 1975 on plates taken with the 122-cm Schmidt telescope at Palomar Mountain and provisionally designated S/1975 J 1. Then, on November 21, 2000, a seemingly new satellite was found out by Scott S. Sheppard, David C. Jewitt, Yanga R. Fernández and Eugen A. Magnier with the 2.2-m reflector on Mauna Kea, and was designated S/2000 J 1. It was soon confirmed that this was the same as the 1975 object. However, a seemingly new satellite was discovered on August 6, 2000 by Matthew J. Holman and his team with the 3.6-m Canada–France–Hawaii telescope on Mauna Kea. The orbit of this confirmed new satellite lies between that of Callisto and the first group of prograde irregulars and is direct, although it is substantially smaller and more inclined than those of the other direct, outer satellites.

Another interesting satellite was discovered on October 6, 1999 by the University of Arizona’s Spacewatch program for discovering outer satellites of Jupiter, and was originally designated an asteroid (1999 UX 18). It was discovered by Timothy B. Spahr and his team with the 1.8-m Spacewatch telescope on Kitt Peak on July 18, 2000 to be in orbit around Jupiter, and given the designation S/1999 J 1. Further observations and measurements indicated that the object is a Jovian satellite.

In October 2002 the names Jupiter XVII Callirrhoe for S/1999 J 1 and Jupiter XVIII Themisto for S/2000 J 1 were approved by the IAU Working Group for Planetary System Nomenclature. The latter is the first satellite to be given an “o” ending, marking Jovian satellites with inclinations of 40–60 degrees or so.

In early December 2000, the team led by Scott S. Sheppard and David C. Jewitt of the University of Hawaii began a systematic search for small irregular moons of Jupiter with the world’s two largest CCD cameras, mounted on the 8.3-m Subaru telescope and the 3.6-m Canada–France–Hawaii telescope atop Mauna Kea. Other members of the team of “satellite hunters” included (among others) Yanga R. Fernández (University of Hawaii), Brett J. Gladman (University of Toronto), John J. Kavelaars (Hertzberg Institute of Astrophysics in Ottawa, Canada), Jan Kleyna (Cambridge University), Eugene A. Magnier (University of Hawaii), and Jan-Marc Petit (Observatoire de Besançon). Ten new satellites including Themisto were discovered in 2000 and eleven other moons in 2001, bringing the total to thirty-nine.

Lots of new names were approved by the Executive Committee of the IAU and the 25th General Assembly of the IAU in Sydney in 2003, as quoted below (2002, *Transactions of the IAU*, XXV A, 141]:

The naming of 11 recently discovered satellites of Jupiter is somewhat overdue, so their provisional names are included here. The satellites are listed in order of increasing distance, while the Roman numerals are in order of recovery announcement on a Minor Planet Circular (MPC).

S/1975 J 1	= XVIII	= Themisto
S/2000 J 3	= XXIV	= Iocaste
S/2000 J 5	= XXII	= Harpalyke
S/2000 J 7	= XXVII	= Praxidike
S/2000 J 9	= XX	= Taygete
S/2000 J 10	= XXI	= Chaldene
S/2000 J 2	= XXIII	= Kalyke
S/1999 J 1	= XVII	= Callirrhoe
S/2000 J 8	= XIX	= Megaclite
S/2000 J 6	= XXVI	= Isonoe
S/2000 J 4	= XXV	= Erinome

The source of the 11 new satellite names is the court of Zeus or Jupiter in Greco-Roman mythology. The names follow the established tradition for the satellites of Jupiter. For the outer satellites the convention is that the satellites in direct orbits have names (mainly Latin) ending in -a, and the satellites in retrograde orbits have names (mainly Greek) ending in -e. The last ten satellites in the current list are thus all in retrograde orbits. With a direct orbit of significantly smaller size and greater inclination than the other outer satellites that have names ending in -a, the first satellite on this list, Themisto, was deliberately given a name with an -o ending, rather coincidentally aligning it with the inner neighbour, Callisto.

Also (2003, *Transactions of the IAU*, XXV B):

The CCD technology has made it possible to discover satellites down to 1 km in size. At some time in the future it may be advisable to stop naming very small satellites. The greatly increased discovery rate of satellites has made it necessary to extend the existing name categories for the satellites of Jupiter and Saturn whose names are drawn from the Greco-Roman mythology. The Jovian satellites have previously been named for Zeus/Jupiter's lovers and favorites, but now Zeus' descendants are also included as allowable source of names. (...)

The following nomenclature (...) has final approval by the XXVth IAU General Assembly:

S/1999 J 1	= Jupiter XVII	= Callirrhoe	Stepdaughter of Zeus/Jupiter
S/1975 J 1	= Jupiter XVIII	= Themisto	Conquest of Zeus
S/2000 J 8	= Jupiter XIX	= Megaclite	Conquest of Jupiter
S/2000 J 9	= Jupiter XX	= Taygete	Conquest of Zeus
S/2000 J 10	= Jupiter XXI	= Chaldene	Conquest of Zeus

S/2000 J 5	= Jupiter XXII	= Harpalyke	Conquest of Zeus
S/2000 J 2	= Jupiter XXIII	= Kalyke	Conquest of Zeus
S/2000 J 3	= Jupiter XXIV	= Iocaste	Conquest of Jupiter
S/2000 J 4	= Jupiter XXV	= Erinome	Conquest of Jupiter
S/2000 J 6	= Jupiter XXVI	= Isonoe	Conquest of Zeus
S/2000 J 7	= Jupiter XXVII	= Praxidike	Conquest of Zeus
S/2001 J 1	= Jupiter XXVIII	= Autonoe	Conquest of Zeus
S/2001 J 2	= Jupiter XXIX	= Thyone	Conquest of Zeus/Jupiter
S/2001 J 3	= Jupiter XXX	= Hermippe	Conquest of Zeus
S/2001 J 11	= Jupiter XXXI	= Aitne	Conquest of Zeus
S/2001 J 4	= Jupiter XXXII	= Eurydome	Conquest of Zeus
S/2001 J 7	= Jupiter XXXIII	= Euanthe	Conquest of Zeus
S/2001 J 10	= Jupiter XXXIV	= Euporie	Daughter of Jupiter
S/2001 J 9	= Jupiter XXXV	= Orthosie	Daughter of Jupiter
S/2001 J 5	= Jupiter XXXVI	= Sponde	Daughter of Jupiter
S/2001 J 8	= Jupiter XXXVII	= Kale	Daughter of Zeus
S/2001 J 6	= Jupiter XXXVIII	= Pasithee	Daughter of Zeus

And (2005, *IAU Circular*, 8502):

Further to IAUC 8177 the IAU WGPSN¹ has approved the following new designations and names of satellites and names of satellites of Jupiter²:

Jupiter XXXIX	Hegemone	= S/2003 J 8
Jupiter XL	Mneme	= S/2003 J 21
Jupiter XLI	Aoede	= S/2003 J 7
Jupiter XLII	Thelxione	= S/2003 J 22
Jupiter XLIII	Arche	= S/2002 J 1
Jupiter XLIV	Kallichore	= S/2003 J 11
Jupiter XLV	Helike	= S/2003 J 6
Jupiter XLVI	Carpo	= S/2003 J 20
Jupiter XLVII	Eukelade	= S/2003 J 1
Jupiter XLVIII	Cyllene	= S/2003 J 13

(2005 March 30, Daniel W.E. Green)

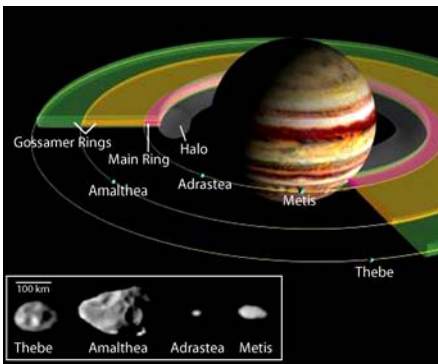
The 61st Jovian satellite was discovered by Scott S. Sheppard and Brett Gladman on April 3, 2003 from images obtained at Mauna Kea, and it was provisionally designated S/2003 J 14. It was later designated Jupiter XLIX and named Kore in April 2007. This name, suggested by the discoverers, must be approved by the IAU General Assembly in Rio de Janeiro in 2009.

¹ Working Group for Planetary System Nomenclature (President: Kaare Aksnes).

² These names are associated with the lovers and daughters of Jupiter/Zeus. The names of the outer irregular satellites should have an -e ending if the inclination is larger than 90, an -a ending if the inclination is about 30, and an -o ending if it is 40 to 60 or so.

Discovering and Naming the Rings

In 1979, the rings of Jupiter were discovered by NASA's two Voyager probes and by E.E. Becklin using the 224-cm Mauna Kea telescope. Images from the Voyager probes first revealed the structure of Jupiter's rings: a flattened main ring (1979 J 2 R) stretching between 122,800 and 129,200 km from the planet's center, and an inner, cloud-like ring called the "halo" (1979 J 1 R), stretching between 100,000 and 122,800 km from the planet's center, both of which consist of small, dark particles. An enhanced Voyager 2 image also seemed to indicate a third, faint outer ring (1979 J 3 R) between 129,200 and 214,200 km away from the planet's center, according to M.R. Showater et al. (1985, "Discovery of Jupiter's gossamer ring," in: *Nature*, 316, 526–528).



Jupiter's rings. Copyright NASA Jet Propulsion Laboratory (NASA-JPL)

In October 1998, images taken during the three orbits of Galileo in 1996 and 1997 revealed that this third ring, known as the gossamer ring because of its transparency, actually consists of two rings. One is embedded within the other, and both consist of microscopic debris from the moons Amalthea and Thebe. It is therefore likely therefore that the main ring comes from Adrastea and Metis, according to J.A. Burns et al. (1999, "The formation of Jupiter's rings," in: *Science*, 284, 5417, 1146–1150).

The main and halo rings consist of dust ejected from the satellites Metis, Adrastea and other unobserved parent bodies as the result of high-velocity impacts. High-resolution images obtained in February and March 2007 by the New Horizons spacecraft revealed a rich fine structure in the main ring.

In visible and near-infrared light the rings have a reddish color, except for the toroidal halo ring, which is neutral or blue in color.

A faint outer protrusion of dust extends beyond the orbit of Thebe. Perhaps this is captured interplanetary dust.

Using the data from NASA's Galileo spacecraft, scientists have shown that Jupiter's shadow is shaping the planet's rings and the orbits of particles within the rings (Krüger H, Hamilton D, 2008, "The sculpting of Jupiter's gossamer ring by its shadow," in: *Nature*, 453, 72).

The parameters for the rings of Jupiter, with the exception of the outer protrusion, are in the following table, which shows their names, their widths and thicknesses, and their distances from the center of Jupiter.

Ring	Width (km)	Thickness (km)	Distance from the center of Jupiter
Halo ring	30,500	12,500	92,000–122,500
Main ring	6,500	30–300	122,500–129,000
Amalthea gossamer ring	53,000	2,000	129,000–182,000
Thebe gossamer ring	97,000	8,40	129,000–226,000

Sources of Satellite Names

Jupiter I IO ($\text{I}\omega$)

Daughter of the river god Inachus and lover of Zeus, who transformed her into a white cow.

Ovidius: *Metamorphoses* 1,583–600 (–776):

River Inachus, hidden away in his deepest cave, augments his waters with his tears, and in utmost wretchedness laments his daughter, Io, as lost. He knows not whether she still lives or is among the shades. But, since she cannot find her anywhere, he thinks she must be nowhere, and his anxious soul forbodes things worse than death.

Jove had seen her returning from her father's stream, and said: "O maiden, worthy of the love of Jove, and destined to make some husband happy, seek now the shade of these deep woods"—and he pointed to the shady woods—"while the sun at his zenith's height is overwarm. But if thou fearest to go alone amongst the haunts of wild beasts, under a god's protection shalt thou tread in safety even the inmost woods. Nor am I of the common gods, but I am he who holds high heaven's sceptre in his mighty hand, and hurls the roaming thunderbolts. Oh, do not flee from me!"—for she was already in flight. Now had she left behind the pasture-fields of Lerna, and the Lyrcean plains thick-set with trees, and the god hid the wide land in a thick, dark cloud, caught the fleeing maid and ravished her.



Apollodorus: Bibliotheca 2,1,3:

Zeus seduced her while she held the priesthood of Hera, but being detected by Hera, he, by a touch, turned Io into a white cow and swore that he had not known her, wherefore Hesiod remarks that lover's oaths do not draw down the anger of the gods. But Hera requested the cow from Zeus for herself and set Argus the All-seeing to guard it (...)

Argus tethered her to the olive tree which was in the grove of the Mycenaeans. But Zeus ordered Hermes to steal the cow, and as Hermes could not do it secretly because Hierax had blabbed, he killed Argus by the cast of a stone, whence he was called Argiphontes. Hera next sent a gadfly to infest the cow, and the animal came first to what is called after the Ionian gulf. Then she journeyed through Illyria and having traversed Mount Haemus she crossed what was then called the Thracian Straits but is now called after her the Bosphorus. And having gone away to Scythia and the Cimmerian land she wandered over great tracts of land and swarm wide stretches of sea both in Europe and Asia until at last she came to Egypt, where she recovered her original form and gave birth to son Epaphus beside the river Nile. Him Hera besought the Curetes to make away with, and make away with him they did. When Zeus learned of it, he slew the Curetes; but Io set out in search of the child she roamed all over Syria, because there it was revealed to her that the wife of the king of Byblus was married to Telegonus, who then reigned over the Egyptians. And she set up an image of Demeter, whom the Egyptians called Isis, and Io likewise they called by the name of Isis.

Jupiter II EUROPA (Ευρώπη)

Daughter of Agenor, lover of Zeus, who approached her in the form of a white bull.

Apollodorus: Bibliotheca 3,1:

Agenor went to Phoenicia, married Telephassa, and begat a daughter Europa and three sons, Cadmus, Phoenix and Cilix. Zeus loved her [Europa].

Ovidius: Metamorphoses 2,846–875:

Majesty and love do not go well together, nor tarry long in the same dwelling-place. And so the father and ruler of the gods, who wields in his right hand the three-forked lightning, whose nod shakes the world, laid aside his royal majesty along with his sceptre, and took upon him the form of a bull. In this form he mingled with the cattle, lowed like the rest, and wandered around, beautiful to behold, on the young grass. His color was white as the untrodden snow which has not yet been melted by the rainy south-wind. The muscles stood rounded upon his neck, a long dewlap hung down in front;



his horns were small, but perfect in shape as if carved by an artist's hand, cleaner and more clear than pearls. His brow and eyes would inspire no fear, and his whole expression was peaceful. Agenor's daughter looked at him in wondering admiration, because he was so beautiful and friendly. But, although he seemed so gentle, she was afraid at first to touch him. Presently she drew near, and held out flowers to his snow-white lips. The disguised lover rejoiced and, as a foretaste of future joy, kissed her hands. Even so he could scarce restrain his passion. And now he jumps sportively about on the grass, now lays his snowy body down on the yellow sands, where her fear has little by little been allayed, he yields his breast for her maiden hands to pat and his horns to entwine with garlands of fresh flowers. The princess even dares to sit upon his back, little knowing upon whom she rests. The god little by little edges away from the dry land, and sets his borrowed hoofs in the shallow water; then he goes further out and soon is in full flight with his prize on the open ocean. She trembles with fear and looks back at the receding shore, holding fast a horn with one hand and resting the other on the creature's back. And her fluttering garments stream behind her in the wind.

Apollodorus: Bibliotheca 3,1:

Zeus conveyed Europa through the sea to Crete. There Zeus bedded with her, and she bore Minos, Sarpedon, and Rhadamanthys; but according to Homer, Sarpedon was a son of Zeus by Laodamia, daughter of Bellerophon. On the disappearing of Europe her father Agenor sent out his sons in search for her, telling them not to return until they had found Europa. With them her mother, Telephassa, and Thasus, son of Poseidon, or according to Pherecydes of Cilix, went forth in search of her. But when, after diligent search, they could not find Europa, they gave up the thought of returning home and took up their abode in diverse places; Phoenix settled in Phoenicia; Cilix settled near Phoenicia, and all the country subject to himself near the River Pyramus he called Cilicia; and Cadmus and Telephassa took up their abode in Thrace and in like manner Thasus founded a city Thasus in an island off Thrace and dwelt there.

Jupiter III GANYMEDE (Γανυμηδης)

Cupbearer of Zeus, who took the form of an eagle and then abducted Ganymede, taking him to Olympus.

Ovidius: Metamorphoses 10,155–159:

The king of the gods once burned with love for Phrygian Ganymede, and something was found which Jove would rather be than what he was. Still he did not deign to take the form of any bird save only that which could bear his thunderbolts. Without delay he cleft the air on his lying wings and stole away the Trojan boy.

Nonnus: *Dionysiaca* 25,430–450:

There well wrought was the Eagle, just as we see in pictures, on the wing, holding him fast in his predatory talons. Zeus appeared to be anxious as he flew through the air, holding the terrified boy with claws that tore not, gently moving the wings and sparing his strength, for he feared that Ganymede might slip and fall headlong from the sky, and the deadly surf of the sea might drown him. Even more he feared the Fates, and hoped that the lovely youth might not first give his name to the sea below and rob Helle of the honor which was reserved for her in the future. Next the boy was depicted at the feast of the heavenly table, as one ladling the wine. There was a mixing bowl beside him full of self-flowing nectarean dew, and he offered a cup to Zeus at the table.



There Hera set, looking furious even upon the shield, and showing her mien how jealousy filled her soul; for she was pointing a finger at the boy, to show goddess Pallas who set next her how a cowboy Ganymedes walked among the stars to pour out their wine, the sweet nectar of Olympus, and there he was handing the cups which were the lot of virgin Hebe.

Nonnus: *Dionysiaca* 33,73–100:

(Ganymedes had much time for games, e.g., for a game of Hymenaios and Eros:)

The umpire in the game was adorable Ganymedes, cupbearer of Cronides, holding the garland. Lots were cast for the shots of unmixed wine, with varied movements of the fingers: these they held out, these they pressed upon the root of the hand closely joined together. A charming match it was between them. (The winner was) the golden son of Cyprogeneia. Ganymedes laughing handed the dainty garland to Eros. Quickly he picked up the beautiful necklace and lifted the globe, and kept the two prizes of their cleverdrop game. Bold Eros went skipping and dancing for joy and turned somersault, and tried often to pull his rival's hands from his sorrowful face.

Jupiter IV CALLISTO (Καλλιςτω)

Arcadian nymph, lover of Zeus. As a penalty for her love, she was changed into a bear.

Ovidius: *Metamorphoses* 2,409-438 and 453-507:

Jove once chanced to see a certain Arcadian nymph, and straightway the fire he caught grew hot to his very marrow. She had no need to spin soft wools nor to arrange her hair in studied elegance. A simple brooch fastened her gown and a white

fillet held her loose-flowing hair. And in this garb, now with a spear, and now a bow in her hand, was she arrayed as one of Phoebe's warriors. Nor was any nymph who roamed over the slopes of Maenalus in higher favour with her goddess than was she. But no favour is of long duration.

The sun was high o'erhead, just beyond the zenith, when the nymph entered the forest that all years had left unfelled. Here she took her quiver from her shoulder, unstrung her tough bow, and lay down upon the grassy ground, with her head pillowed on her painted quiver. When Jove saw her there, tired out and unprotected: "Here, surely," he said, "my consort will know nothing of my guile; or if she learn it, well bought are taunts at such a prize." Straightway he put on the features and dress



Eros, Zeus as Artemis, Kallisto

of Diana and said: "Dear maid, best loved of all my followers, where hast thou been hunting today?" The maiden arose from her grassy couch and said: "Hail thou, my goddess, greater far than Jove, I say, though he himself should hear." Jove laughed to hear her, rejoicing to be prized more highly than himself; and he kissed her lips, not modestly, nor as a maiden kisses. When she began to tell him in what woods her hunt had been, he broke in upon her story with an embrace, and by this outrage betrayed himself. She, in truth, struggled against him with all her girlish might—hadst thou been there to see, Saturnia, thy judgment were more kind!—but whom could a girl o'ercome, or who could prevail against Jove? Jupiter won the day, and went back to the sky.

(...) Nine times since then the crescent moon had grown full orb'd, when (...) her shame was openly confessed. As she stood terrorstricken, vainly striving to hide her state, Diana (...) expelled her from her company. The great Thunderer's wife had known all this long since; but she had put off her vengeance until a fitting time. And now that time was come; for, to add a sting to Juno's hate, a boy, Arcas, had been born of her rival. (...) She caught her by the hair full in front and flung her face-foremost to the ground. And when the girl stretched out her arms in prayer for mercy, her arms began to grow rough with black shaggy hair; her hands changed into feet tipped with sharp claws; and her lips, which but now Jove had praised, were changed to broad, ugly jaws; and, that she might not move him with entreating prayers, her power of speech was taken from her, and only a harsh, terrifying growl came hoarsely from her throat. Still her human feeling remained, though she was now a bear; with constant moanings she shows her grief, stretched up such hands as are left her to the heavens, and, though she cannot speak, still feels the ingratitude of Jove. (...)

And now Arcas, Lycaon's grandson, had reached his fifteenth year, ignorant of his mother's plight. While he was hunting the wild beasts, seeking out their favourite haunts, hemming the Arcadian woods with his close-wrought nets, he chanced upon his mother, who stopped still at sight of Arcas, and seemed like one that recognized him. He shrank back at those unmoving eyes that were fixed forever upon him, and feared he knew not what; and when she tried to come nearer, he was just in the act

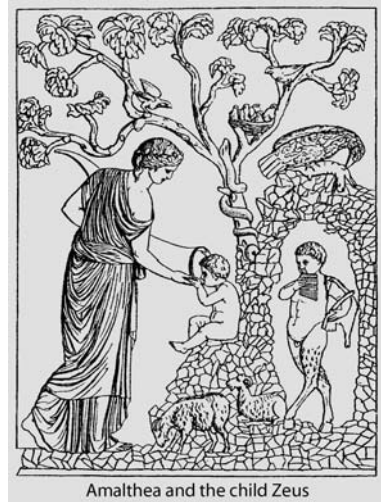
of piercing her breast with his wound-dealing spear. But the Omnipotent stayed his hand, and together he removed both themselves and the crime, and together caught up through the void in a whirlwind, he set them in the heavens and made them neighbouring stars.

Jupiter V AMALTHEA (Αμαλθεία)

A Naiad, nurse of Zeus in a cave on mount Ida.

Ovidius: Fasti 1,115–128:

The Naiad Amalthea, famous on the Cretan Mount Ida, is said to have hidden (the newborn) Jupiter in the woods. She owned a she-goat, conspicuous among the Dictaeon flocks, the fair dam of two kids; her airy horns bent over her back; her udder was such as a nurse of Jove might have. She suckled the god. But she broke a horn on a tree, and was shorn of half her charm. The nymph picked up, wrapped it in fresh herbs, and carried it, full of fruit, to the lips of Jove. He, when he had gained the kingdom of heaven and sat on his father's throne, and there was nothing greater than unconquered Jove, made his nurse and her horn of plenty (cornucopiae) into stars: the horn still keeps its mistress' name.



Amalthea and the child Zeus

Hyginus: Astronomia 2,13,4:

Musaeus (of Thracia) says that Jupiter was nursed by Themis and the nymph Amalthea ... Amalthea had as a favourite animal a goat which is said to have nourished Jupiter.

Hyginus: Fabula 182:

Idothea, Amalthea, Adrastea, the daughters of Oceanus—according to others they were the daughters of Melisseus—were the nurses of Jupiter.

(According to Callimachus, *Hymni 1,25–50*, Adrastea was the name of the nurse and Amalthea that of the goat; see Jupiter XV).

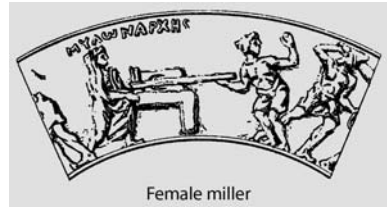
Jupiter VI HIMALIA (Ιμαλία)

A Rhodian nymph, goddess of harvesting, by whom Zeus begat three sons.

Diodorus Siculus 5,55,1–5:

The island which is called Rhodes was first inhabited by the people who were known as Telchines; these were the children of Thalatta (the sea), as the mythical tradition

tells us, and the myth relates that they, together with Capheira, the daughter of Oceanus, nurtured Poseidon, whom Rhea committed as a babe to their care. And we are told that they were also the discoverers of certain arts and that they introduced other things which are useful for the life of mankind. They were



Female miller

also the first, men say, to fashion statues of gods, and some of the ancient images of gods have been named after them; so, for example, among the Lindians there is an “Apollo Telchinus”, as it is called, among the Ialysians a Hera and Nymphae, both called “Telchinian”, and among the Cameirans a “Hera Telchinia”. And men say that the Telchines were also wizards and could summon clouds and rain and hail at their will and likewise could even bring snow; these things, the accounts tell us they could also change their natural shapes and were jealous of teaching their arts to others.

Poseidon, the myth continues, when he had grown to manhood, became enamoured of Halia, the sister of the Telchines, and lying with her he begat six male children and one daughter, called Rhodos, after whom the island was named. And at this period in the eastern parts of the island there sprung up the Giants, as they were called; and at the time when Zeus is said to have subdued the Titans, he became enamoured of one of the nymphs, Himalia by name, and he begat by her three sons, Spartaeus, Cronios, and Cytus.

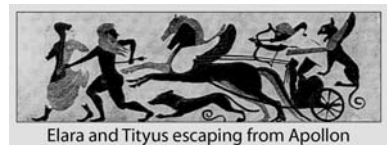
Other names used for Himalia: Ima (*Clemens Romanus: Homiliae* 5,13), Halia (*Iulius Firmicus Maternus: De errore profanarum religionum libellus, ed. Bursian p. 54*).

Jupiter VII ELARA (Ελαρα)

Daughter of Orchomenus, a paramour of Zeus, and by him the mother of the giant Tityus.

Strabo: Geographika 9,3,14:

Panopeus, the Phanoteus of today, borders on the region of Lebadeia (...) The scene of the myth of Tityus is laid here. Homer says that the Phaeacians “led” Rhadamanthys into Euboea “to see Tityus, son of the Earth”. And a cave called Elarium is to be seen in the island, named after Elara the mother of Tityus; and also a hero-temple of Tityus, and certain honours which are paid to him.



Elara and Tityus escaping from Apollon

Apollodorus: Bibliotheca 1,4,1:

Not long afterwards (Apollo) slew also Tityus, who was a son of Zeus and Elara, daughter of Orchomenus; for her, after he had debauched her, Zeus hid under the earth for fear of Hera, and brought forth to light the son Tityus, of monstrous size, whom she had born in her womb.

(Likewise *Pherekydes, in: Scholia in Apollonium Rhodium Vetera, 760–762a.*)

Jupiter VIII PASIPHAË (Πασίφαη)

Wife of Minos, King of Crete; she fell in love with a bull (Taurus) which was sent by Zeus or was Zeus himself. She became the mother of the Minotaur or (according to another tradition) the mother of Ammon by Zeus.

Plutarchus: Agis et Cleomenes, Agis 9,2:

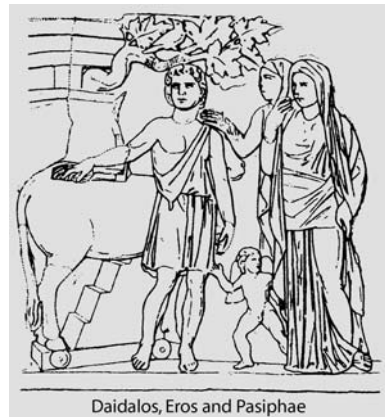
Now there was a temple of Pasiphae at Thalamae, and her oracle there was held in honour. Some say that Pasiphae was one of the daughters of Atlas, and the mother of Ammon by Zeus.

Epiphaneus: Ancoratus 105:

He (Jupiter) had made approaches to Pasiphae and Europa as a bull.

Ovidius: Ars Amatoria 1,317–326:

Pasiphae, longing for a bestial mate,
 Eyed the fair cows with jealousy and hate. (...)
 She had her harmless victim, as she spoke,
 Torn from the herd and set to bear the yoke,
 Or, a sham offering, at the altar felled,
 And gloated her rival's heart she held.
 Oft to the Gods her rivals did she vow,
 And took their heart's and said "Go charm
 him now!"
 And for Europa's lot or Io's prayed,
 One the bull's rider, one the heifer-maid;
 Till cozoned by a wooden cow his seed
 He gave her, and the child betrayed its breed.



Daedalus, Eros and Pasiphae

Apollodorus: Bibliotheca 3,15,1 and 3,13–4:

Now if any woman had intercourse with Minos, it was impossible for her to escape with life; for because Minos cohabited with many women, Pasiphae bewitched him, and whenever he took another woman to his bed, he discharged wild beasts at her joints, and so the women perished.

Poseidon did send him up a fine bull (...) and contrived that Pasiphae should conceive a passion for it. In her love for the bull she found an accomplice in Daedalus, an architect, who had been banished from Athens for murder. He constructed a wooden cow on wheels, took it, followed it out in the inside, sewed it up in the hide of a cow which he had skinned, and set it in the meadow in which the bull used to graze. Then he introduced Pasiphae into it; and the bull came and coupled with it, as if it were a real cow. And she gave birth to Asterius, who was called the Minotaur. He had the face of a bull, but the rest of him was human; and Minos, in compliance with certain oracles, shut him up and guarded him in the Labyrinth.

Mythographi Tres (Vaticani) 1,43:

Now it happened that Pasiphae, daughter of the sun, wife of Minos, king of Crete, fell in love with a bull; thanks to the craftsmanship of Daedalus, being shut up in a wooden cow which was covered with the skin from a very beautiful cow, she had sexual intercourse with the bull. As a result of this union the Minotaur was born who then was locked up into the labyrinth and fed on human flesh (...)

The truth, however, is: Taurus was a notary of Minos, and Pasiphae fell in love with him and cohabited with him in the house of Daedalus. She gave birth to twins, and as a result one of them was the son of Minos and the other the son of Taurus; therefore they say that she gave birth to the Minotaur.

Jupiter IX SINOPE (ΣΙΝΩΠΗ)

Daughter of the river god Asopos, lover of Zeus, who granted her perpetual virginity after he had been perceived by his own promises.

Apollonius Rhodius: Argonautica 2,946–951:

Soon after this they stepped on to Assyrian territory, where Zeus had settled Sinope, the daughter of Asopos, and had granted perpetual virginity, after he had been perceived by his own promises. He desired to make love to her, and promised to give her whatever her heart desired; she then cunningly asked that he allow her to remain a virgin. In this same way she also fooled Apollo who wanted to sleep with her, and after them also the River Halys. No man ever took away her virginity in embraces full of desire.



Sinope

Valerius Flaccus: Argonautica 5,107–119:

And next, as the vessel speeds along, they send deep beneath the horizon Cromne's ridge and pale Cytorus and thee, Erythia. And now heaven was bringing back the night; closely skim they high Carambis, and vast upon the sea trembles the shadow of Sinope. Embosoming Assyrian bays stands rich Sinope, once a nymph and one who mocked Jove's ardent wooing, unmoved by heavenly suitors; not Halys only or Apollo were deceived by the trickery of the nymph they loved.

Strabo: Geographica 12,3,11:

Eupator was both born and reared at Sinope; and he accorded it especial honour and treated it as the metropolis of his kingdom. Sinope is beautifully equipped both by nature and by human foresight, for it is situated on the neck of a peninsula, and has on either side of the isthmus harbours and roadsteads and wonderful pelamydes-

fisheries, of which I have already made mention, saying that the Sinopeans get the second catch and the Byzantians the third.

Jupiter X LYSITHEA (Λυσιθεα)

Daughter of Kadmos, identified with Semele, mother of Dionysos by Zeus. According to others, she was the daughter of Evenus and the mother of Helenus by Zeus.

Joannes Lydus: De Mensibus 4,38:

In accordance with the opinion of the poets there are five Dionysus's in total, the first of which was born by Lysithea to Jupiter.

Clemens Romanus: Recognitiones 10,21:

And these are indeed the conquests of Jove: (...) Lysithea, the daughter of Evenus, who gave birth to Helenus.

Apollodorus: Bibliotheca 3,4,3 and 3,5,2-3:

Zeus loved Semele (Lysithea) and bedded with her unknown to Hera. Now Zeus had agreed to do for her whatever she asked, and deceived by Hera she asked that he would come to her as he came when he was wooing Hera. Unable to refuse Zeus came to her bridal chamber in a chariot with lightning and thunder, and launched a thunderbolt. But Semele expired of fright, and Zeus, snatching the six month abortive child from the fire, sewed it in his thigh. (...) But at the proper time Zeus undid the stitches and gave birth to Dionysus.

And having shown the Thebans that he was a god, Dionysus came to Argos, and there again, because they did not honour him, he drove the women mad, and they on the mountains devoured the flesh of the infants whom they carried at their breasts. (...) Thus men perceived that he was a god and honoured him; and having brought up his mother from Hades and named her Thyone, he descended up with her to heaven.



Satyr, Apollon, Dionysos and Semele-Lysithea-Thyone in Olympus

Jupiter XI CARME (Καρμη)

A nymph and companion of Artemis, mother of Britomartis by Zeus.

Clemens Romanus: Recognitiones 10,21:

And these are indeed the conquests of Jove: (...) Carme, the daughter of Foenix, who gave birth to Britomartis who was a companion of Diana.

Pausanias 2 (Corinth), 30,3:

The Cretans say that Carmanor (...) was the father of Eubulus, and that the daughter of Zeus and of Carme, the daughter of Eubulus, was Britomartis. She took delight, they say, in running and in the chase, and was very dear to Artemis. Fleeing from Minos, who had fallen in love with her, she threw herself into nets which had been cast for a draught of fishes. She was made a goddess by Artemis.

Vergilius: Ciris 220–296, 487–489, and 520–541:

(During a war, Carme was taken as a prisoner from Crete to Megara/Attica, where she became the nurse to the king's daughter Scylla. Growing up, Scylla fell in love with Minos, King of Crete, who besieged the town. Minos promised to marry her as soon as she delivered her father's beautiful locks to him; those locks gave her father the power to protect his city. Carme loudly lamented her father's death and her own destiny.)

Affrighted by the fell disaster, Carme defiles her unshorn locks with a shower of dust, and in aged accents makes grievous lamentation: "O Minos, who now a second time hast visited upon me thy cruelty! O Minos, in my old age a second time my enemy! How truly through thee, and thee alone, has Love ever brought grief, either to my child in other days, or now to my distraught fosterling! Have I, who was taken captive and carried off to this distant land, who have suffered such grievous servitude and harsh travails, have I failed to escape thee, O thou who art already for the second time the cruel destruction of my loved ones? Now, now, even for me, who am older than is meet, there lives no child, so that I may long to live. Why have I, frenzied one, when thou, Britomartis, the sole hope of my tomb, wert torn from me—why have I been able to prolong my day of life?"



(However, Carme followed Scylla to Minos, verbosely supporting her. Minos looked away. He had achieved his goal and hung Scylla on the bow of his ship. Neptune's spouse released her:)

... rather she raised her aloft on airy wings, that she might live on earth as Ciris, named from the deed wrought—Ciris, more beautiful than Leda's Amyclaeon swan. (...) Yet even this was not without penalty: for the king of the gods, who with his power sways all regions of the world, being grieved that a maid so wicked should be flitting to the world above, while under dark night's cover her father's light was quenched (... He) granted under changed form the life he had craved, and suffered him to be on earth a winged sea-eagle (...) So the sea-eagle and the Ciris, with ever reminding fate, maintain the fierceness of mutual wrath from age to age.

Jupiter XII ANANKE (Αναγκη/Necessitas)

Goddess of necessity, mother ofAdrastea by Zeus, the goddess who rewards men for their deeds.

Plutarchus: De Sera Numinis Vindicta 25 (564 E):

Thespesins' kinsman (...) proceeded to explain. Adrastea, he said, daughter of Ananke (Necessity) and Zeus, is the supreme requiter; all crimes are under her cognizance, and none of the wicked is so high or low as to escape her either by force or by stealth.

Plato: Politicus 10, 14:

They reached this point after progressing a further day's travelling, and they saw down the centre of the light the ends of its bonds attached from the sky (...), and from these ends was suspended the spindle of necessity, through which all the heavenly rotations turned. The spindle's shaft and hook were of adamant, while its whorl was of a mixture of adamant and other materials. The nature of the whorl was as follows: its shape was like a spindle here on earth, but judging by Er's description of it we must imagine that it was as it would be if within one great hollow carved out whorl another smaller one of the same kind were fitted in—like vessels which fit inside one another—and then a third and a fourth fitted in the same way, and so on with four more.

**Horatius Flaccus: Odes 1,35 and 24,1–7:**

Cruel necessity always goes before you, bearing great nails and wedges in her brazen hand; nor is the cruel hook wanting or the plummet of melted lead.

Although you fill the Tuscan and Apulian seas with your houses, and palaces although you are possessed of greater richness than can be found in the untouched treasures of Arabia, and opulent India; yet if once cruel Necessity fix her adamantine claws upon these fifty edifices, you'll neither be able to free your mind from fear, nor deliver yourself from the stroke of death.

Jupiter XIII LEDA (Ληδα)

The wife of Tyndareus, King of Sparta; seduced by Zeus in a form of a swan, she bore him Pollux and Helen.

Apollodorus: Bibliotheca 3,10,5–7:

(The Lakedaimonian ruler) Tyndareus married Leda, daughter of Thestius. But afterwards, when Hercules slew Hippocoon and his sons, they returned, and Tyndareus succeeded to the kingdom.

Icarius and Periboea, a Naiad nymph, had five sons, Thoas, Damasippus, Imeusimus, Aletes, Perileos, and a daughter Penelope, whom Ulysses married; also another daughter Phylonoe, whom Artemis made immortal. But Zeus in a form of a swan consorted with Leda, and on the same night Tyndareus cohabited with her, and she bore Pollux and Helen to Zeus, and Castor and Clytemnaestra to Tyndareus. But some say that Helen was the daughter of Nemesis and Zeus; for that she, flying from the arms of Zeus, changed herself into a goose, but Zeus in his turn took the likeness of a swan and so enjoyed her, and as the fruit of their loves she laid an egg, and a certain shepherd found it in the groves and brought and gave it to Leda; and she put it in a chest and kept it; and when Helen was hatched in due time, Leda brought her up as her own daughter.



Leda

Euripides: Helena 16–21:

Helen: “For me, not fameless is my fatherland Sparta: my sire was Tyndareus. The tale telleth that to my mother Leda flew Zeus, who had stolen the likeness of a swan, and, fleeing from a chasing eagle, wrought by guile his pleasure—if the tale is true.”

Homerus: Odyssea 11,298–304:

And I saw Leda, the wife of Tyndareus, who bore to Tyndareus two sons, stout of heart, Castor the tamer of horses, and the boxer Polydeuces. These two the earth, the giver of live, covers, albeit alive, and even in the world below they have honour from Zeus. One day they live in turn, and one day they are dead: and they have won honour like unto that of the gods.

Jupiter XIV THEBE (Θηβη)

An Egyptian king’s daughter, granddaughter of the mother of Aigyptus by Zeus.

Pausanias 5 (Elis) 22,5–7:

The Phliasians dedicated a Zeus, the daughters of Asopus, and Asopus himself. Their images have been ordered thus: Nemea is the first of the sisters, and after her comes Zeus seizing Aegina; by Aegina stands Harpina, who (...) mated with Ares and was the mother of Oenomaus, king around Pisa; after her is Corcyra, with Thebe next; last of all comes Aesopus.



Thebe

There is a legend about Corcyra that she mated with Poseidon, and the same thing is said by Pindar of Thebe and Zeus.

Joannes Lydus: *De Mensibus* 4,46:

From historians we learn that there were seven Hercules's in total, ... The fourth of them was the son of Jupiter and the Egyptian Thebe.

Johannes Tzetzes: *Scholia ad Lycophronem* 1206:

Another historian says: Zeus cohabited with Thebe and became the father of Aigyptos whose daughter was Karchos, and therefore it appears clear that the city in Egypt is called Thebes and the island Carchedon.

Jupiter XV ADRASTEIA (ΑΔΡΑΣΤΙΕΑ)

A nymph of Crete, who was entrusted by Rhea to care for the infant Zeus.

Callimachus: *Hymnus* 1 (to Jupiter), 25–50:

Then, I wot, constrained by perplexity, anguish Rhea said: "Dear Earth, do thou, too, bear; for easy are thy throes." The goddess spake, and having uplifted on high her great arm smote the mountain with a staff. So it was rent widely asunder at her bidding, and poured forth a vast flood. Therein having cleansed thy skin, O king, she swathed thee, and gave thee to Neda to carry into a secret place in Crete, that so thou mightest be reared stealthily: to Neda most honoured of the Nymphs, who then were her mid-wives, and eldest-born after Styx and Philyra.

Nor did the goddess pay back vain thanks: for she named that flood Neda, which in full force somewhere over-against the very city of the Caucones, which is called Leprium, mingles with the sea; and the sons of Lycaon's daughter, the shebear, drink it as the most ancient water. When the nymph was leaving Thenae, carrying thee, father Jove, towards Cnossus (Thenae was nigh to Cnossus), then fell thy navels, O god: whence afterward the Cydonians call that plain Omphalian. But thee, O Jove, the associated of the Corybantes, the Dictaeon Meliae, took-to-their-arms:Adrastea lulled thee in a golden cradle: thou sackedst the full teat of the goat-Amalthea, and more-over atest sweet honey.

Hyginus: *Fabula* 182:

Idothea, Amalthea, Adrastea, the daughters of Oceanus—according to others they were the daughters of Melisseus—were the nurses of Jupiter.

Apollonius Rhodius: *Argonautica* 3,133–141:

(Ganymede was easy game for Eros,) without seeing Kypris approach. She stood in front of her son, at once touched his chin and spoke to him: "Why are you grinning, you unspeakable horror? Have you pointlessly deceived him, unjustly getting the better of an innocent child? Please now, willingly do what I say. If you do, I will give you

that lovely toy of Zeus which her dear nurse Adrastea made for him when he was still a babbling baby in the Idaian cave. It is a round ball, and you will get no better plaything from the hands of Hephaistos. Its zones are golden, and two circular joins curve around each of them; the seams are concealed, as a twisting dark-blue pattern plays over them; the seams are concealed, as a twisting dark-blue pattern plays over them. If you throw up with your hands, it sends a flaming furrow through the sky like a star.

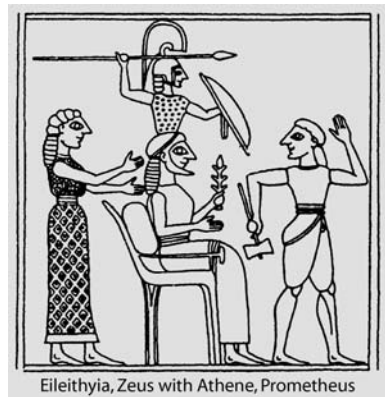
Jupiter XVI METIS (Μητις)

First wife of Zeus. He swallowed her when she became pregnant; Athenae was subsequently born from the forehead of Zeus.

Hesiodus: Theogonia 886–900:

But when, I wot, the blessed gods had fulfilled their labor, and contended with the Titans perforce on the score of honours, then it was, I say, that they urged far-seeing Jove, by the advice of Earth, to rule and reign over immortals: and the duty distributed honours amongst them.

And Jupiter, king of the gods, made Metis (“prudentia”) first his wife; Metis, most wise of deities as well as mortal men. But when now at length she was about to give birth to Minerva, gleaming-eyed goddess, then it was that having by deceit beguiled her mind with flattering words, he placed her within his own belly by the advice of Earth, and of starry Heaven. For thus they persuaded him, lest other of ever-living gods should possess sovereign honour in the room of Jove. For of her it was fated that wise children should be born: first the glancing-eyed Tritonian maiden, having equal might and prudent counsel with her sire, and then, I ween, she was going to give-birth-to a son, as king of gods and men, with an over bearing spirit, but *that* in sooth Jove deposited her first in his own belly, that the goddess might indicate to him both good and bad.



Eileithyia, Zeus with Athene, Prometheus

Apollodorus: Bibliotheca 1,2,1 and 1,3,6:

But when Zeus was full-grown, he took Metis, daughter of Ocean, to help him, and she gave Cronus a drug to swallow, which forced him to disgorge first the stone and then the children whom he had swallowed, and with their aid Zeus waged the war against Cronus and the Titans.

Zeus had intercourse with Metis, who turned into many shapes in order to avoid his embraces. When she was with child, Zeus, taking time by the forelock, swallowed her, because Earth said that, after giving birth to the maiden who was then in her

womb, Metis would bear a son who should be the lord of heaven. From fear of that Zeus swallowed her. And when the time came for the birth to take place, Prometheus or, as others say, Hephaestus, smote the head of Zeus with an axe, and Athena, fully armed, leaped up from the top of his head at the river Triton.

Jupiter XVII CALLIRRHOE (Καλλιρροη/Καλλιροη)

Daughter of the river god Achelous and stepdaughter of Jupiter.

Apollodorus: Bibliotheca 3,7,4–6:

(Alcmaeon, commander of the Epigony, lost the war for Thebes and escaped northward pursued by the Erinnyes for having killed his mother. In his baggage he had her divine presents, a necklace and a robe. Alcmaeon fled to Phegeus at Psophis. He married the daughter of Phegeus and passed the divine presents over to her. The Erinnyes, however, continued to plague him. The Delphic Oracle advised Alcmaeon to approach the river god Achelous, by whom he was purified.)

He received Achelous's daughter Callirrhoe to wife. Moreover he colonized the land which the Achelous had formed by its silt, and he took up his abode there. But afterwards Callirrhoe coveted the necklace and robe, and said she would not live with him if she did not get them. So away Alcmaeon hied to Psophis and told Phegeus how it had been predicted that he should be rid of his madness when he had brought the necklace and the robe to Delphi and dedicated them. Phegeus believed him and gave them to him. But a servant having let out that he was taking the things to Callirrhoe, Phegeus commanded his sons, and they lay in wait and killed him. (...) Being apprized of Alcmaeon's untimely end and courted by Zeus, Callirrhoe requested that the sons she had by Alcmaeon might be full-grown in order to avenge their father's murder. And being suddenly full-grown, the sons went forth to right their father's wrong.

Ovidius: Metamorphoses 9,413–417:

Themis's prophecy: (Alcmaeon) shall be hounded by the Furies and by his mother's ghost until his wife (Callirrhoe) shall ask of him the fatal golden necklace and the sword of Phegeus shall have drained his kinsman's blood. And then at last shall Callirrhoe, daughter of Achelous, by prayer obtain from mighty Jove that her infant sons may attain at once to manly years, and that he shall not allow their avenging father's death to go unavenged. Jove, thus prevailed upon, shall claim in advance for these the gifts of his stepdaughter and daughter-in-law (both Hebe) and shall in an act change beardless boys to men.

Jupiter XVIII THEMISTO (Θεμιστω)

Daughter of the Arcadian river god Inachus, mother of Ister by Zeus.

Clemens Romanus: Recognitiones 10,21:

Themisto, daughter of the Arcadian river god Inachus, mother of Ister by Zeus.

(The Arcadian Themisto, who had a love affair with Zeus, should not be confused with the Thessalian Themisto, who by mistake ordered her guards to kill her own twins.)

Stephanus Byzantius, in: Fragmenta Historicorum Graecorum p. 426, frg 57):

Ister according to tradition is the daughter of the Arcadian Themisto and Zeus; this name has been selected because the mother was transformed into a beast; it was Hera to be precise who had changed her into a bear (arktos).

Eustatius: Ad Homeri Iliadem 300,29:

The eldest tribes of the Greeks seem to be, they say, the Arcadians. Therefore the Arcadians are called pre-lunar, just as they were called, they say, also by Hippys of Reginos. Paraphrasing this, Lycophron said that the Arcadians in pre-lunar times had lived on acorns. According to the comedian (Aristophanes), however, the word of the pre-lunarians is composed of σελυνος (belonging to the moon) and βεκε, words meaning extremely old age and simplicity. At the time, they say, the constellation the Plough was renamed the Bear (Arkas) after Arkas the son of Zeus and Themisto who had received this name owing to the transformation of the mother into a beast. For Themisto, they say, had become a bear by Hera. Their country, a mountainous region situated amidst the Peloponnes, according to geographers, is named Arcadia.

Ernst Maaß (1906) Panychis, in: Jahrbuch des Deutschen Archäologischen Instituts, 21, 104:

(Themisto, a name which is derived from Themis, a motherly deity, mother of the Moires/Fates and Horae/Seasons by Zeus, and) in this function the prophet of things to come and advisor of current events (...) in Arcadia this being is named Themisto or Megisto as also Kallisto, a name which has become popular by chance.

Jupiter XIX MEGACLITE (Μεγακλιτη)

Daughter of Macareus, who gave birth to Thebe and Locrus by Zeus.

Clemens Romanus: Recognitiones (transl. Rufinus) 10,20-21:

Overlooking all the generations of those who are called the gods I have to state that their bastardy deeds are boundless. Graciously ignoring the others I shall report on the one whose offences are the worst, namely the shameful deeds committed by Jupiter. (One of his adulterous conquests was) Megaclite, the daughter of Macareus, who gave birth to Thebe and Locrus.

Jupiter XX TAYGETE (Ταυγετη/Τηυγετη/Τηυγετη)

Daughter of Atlas, one of the Pleiades, mother of Lakedaemon by Zeus.

Nonnus: Dionysiaca 32,60-65:

And her (Hera's) consort (Zeus) glowing made reply: "Beloved bride, let quarrels be! (...) Let a bridebed receive us both! Not for any mate, neither mortal woman nor

goddess, was I ever so charmed in soul at the touch of a cestus; no, not even when I had Teygete, Atlas's daughter, from whose bed was born Lacedaemon the ancient prince.

Apollodorus: Bibliotheca 3,10,3:

Taygete had by Zeus a son Lacedaemon; after whom the country of Lacedaemon is called.

Pausanias 3 (Laconia), 1,1-2:

According to the tradition of the Lacedaemonians themselves, Lelex, an aboriginal, was the first king in this land (...) Lelex had a son Myles. (...) On the death of Myles his son Eurotas succeeded to the throne. (...) Having no male issue, he left the kingdom to Lacedaemon, whose mother was Taygete, after whom the mountain was named, while according to report his father was none other than Zeus. Lacedaemon was wedded to Sparta, a daughter of Eurotas.

Pindarus: Carmina, Olympionicae 3,29:

Then it was that his (Theron of Acragas's) heart urged him to go to the Istrian land, where Leto's horse-driving daughter had welcomed him on his arrival from Arcadia's ridges and much-winding valleys, when through the commands of Eurystheus his father's compulsion impelled him to bring back the golden-horned doe, which formerly Taygete had inscribed as a holy offering to Orthosia (Artemis).

Scholia in Pindari Carmina, Scholia in Olympionicas 3,53:

Artemis transformed Taygete into a hind and thus enabled her to elude Zeus's pursuits. Having received later once more the human figure, Taygete in gratitude dedicated to Artemis a hind. This hind later was slain by Hercules.

Pseudo-Plutarchus: De Fluviiis 17,3:

Situated nearby is Mount Taygetus the name of which goes back to the nymph Taygete who was raped by Zeus and because of this ruined by him. Being fully distressed she finished her life on the summit of Mount Amyclaeus by a cord. And for that very reason it was named Taygetus.

Jupiter XXI CHALDENE (Χαλδηνη)

Lover of Zeus and mother of Solymos by him.

Stephanus Byzantius: Ethnicon p. 524:

The Pisidians, previously named Solymnes from Solymos a son of Zeus and Chaldene. The Pisidians are a barbaric people living in Aspedon and Kilikia.

Jupiter XXII HARPALYKE (Αρπαλυκη)

Daughter of Clymenus, was transformed into the night bird Chalcis after she had intercourse with her father or, according to others, with Zeus.

Scholia Graeca in Homeri Iliadem 14,291:

The woman (Harpalyke) had intercourse with Zeus, and because of this she was transformed into a night bird called Chalcis.

Parthenius: Fragmenta. Harpalyce:

Clymenus the son of Teleus at Argos married Epikaste and had two sons who were called Idas and Therager, and a daughter, Harpalyke, who was far the most beautiful woman of her time. Clymenus was seized with love of her. For a time he held out and had the mastery of his passion; but it came over him again with increased force, and he then acquainted the girl of his feelings through her nurse, and consorted with her secretly. However, the time arrived when she was ripe for marriage, and Alastor, one of the race of Neleus, to whom she had previously been betrothed, had come to wed her. Clymenus handed her over to him without hesitation, and celebrated the marriage in magnificent style. But after no long period his madness induced him to change his mind; he hurried after Alastor, caught the pair of them when they were half-way on their journey, seized the girl, took her back to Argos, and there lived with her openly as wife. Feeling that she had received cruel and flagitious treatment at her father's hands, she killed and cut in pieces her younger brother, and when there was a festival and sacrifice being celebrated among the people of Argos at which they all feast at a public banquet, she cooked the boy's flesh and set it as meat before her father. This done, she prayed Heaven that she might be translated away from among mankind, and she was transformed into the bird called Chalcis. Clymenus when he began to reflect on all these disasters that had happened to his family, took his own life.

Hyginus: Fabulae 255,246,242:

Those who lacked deference: Harpalyce the daughter of Clymenus killed the son whom she had born after having intercourse with her father.

Those who ate their children on the occasion of a banquet: Clymenus, son of Schoenus, ate his son born by Helike, his daughter.

Those who killed themselves: Clymenus, son of Schoenus, king of Arcadia, killed himself for having had intercourse with his daughter.

Nonnus: Dionysiaca 12,69–75:

This was the prophecy to be read in the tablets: Hera's herdsman Argos shall change form to bird, with the appearance of his grim eyes made bright. Harpalyke after the bed of criminal nuptials shall carve up her son for her incestuous father, and paddle a winged course through the air as a storm-swift bird ...

Jupiter XXIII: KALYKE (Καλυκη)

Mother of Endymion by Zeus, who granted him eternal youth and everlasting sleep.

Apollodorus: Bibliotheca 1,7,3,5:

Aeolus reigned over the regions about Thessaly and named the inhabitants Aeolians. He married Enarete, daughter of Deimachus and begat (...) Kalyke.

Kalyke and Aethlius had a son Endymion who led Aeolians from Thessaly and founded Elis. But some say he was a son of Zeus. As he was of surpassing beauty, the Moon fell in love with him and Zeus allowed him to choose what he would, and he choose to sleep for ever,

Remaining deathless and ageless.

Scholia in Apollonium Rhodium Vetera 4,57:

Endymion, according to Hesiod a son of Aithlios and Kalyke, was given by Zeus, sunlight, eternal youth and everlasting sleep, as presents.

Jupiter XXIV IOCASTE (Ιοκαστη)

The mother of Agamedes by Jupiter.

Scholia in Aristophanem Nubium 508:

Iocaste, as some say, was the mother of Agamedes by Jupiter.

Pausanias 9 (Boeotia), 5,10:

When Laius was king and married to Iocaste, an oracle came from Delphi that, if Iocaste bore a child, Laius would meet his death at his son's hands. Whereupon Oedipus was exposed, who was fated when he grew up to kill his father; he also married his mother.

Sophocles: Oedipus Tyrannus 636–1073:

(Oedipus, son of Iocaste and Laius, the King of Thebes, was abandoned by him in order to prevent a bad oracle concerning their newborn child. He was, however, saved by a shepherd and presented as a gift to Polybius, the childless king of Corinth, and his wife Merope. Growing up, he came to know of a Delphian oracle that predicted his fate, and so he left Corinth to find this. On the way to Thebes, he unwittingly killed his father Laius in a quarrel. He then succeeded in freeing Thebes from the Sphinx, and as a reward he became successor to the throne and took the widowed queen Iocaste as consort. It was rumoured that he had killed Laius. Iocaste tried to soothe him:)

Listen and I'll convince thee that no man hath scot or lot in the prophetic art. Here is the proof in brief. An oracle once came to Laius (...) declaring he was doomed to perish by the hand of his own son, a child that should be born by him and me.

Now Laius—so at least report confirmed—was murdered on a day by highwaymen, no natives, at a spot where three roads meet. As for the child, it was but three days old, when Laius, its ankles pierced and pinned together, gave it to be cast away by others on the trackless mountain side. So then Apollo brought it not to pass the child should be his father's murderer, or the dread terror find accomplishment, and Laius be slain by his own son. Such was the prophet's horoscope. O king, regard it not. Whate'er the god deems fit to search, himself unaided will revail.

(More and more facts made Oedipus wonder, while Iocaste asked him to cease his inquiries:)

Iocaste: "What matter? Let it be ..."

Oedipus: "No, with such guiding clues I cannot fail to bring to light the secret of my birth."

Iocaste: "Oh, as thou carest for thy life, give o'er this quest. Enough the anguish I endure."

(In vain, at last the full truth came to light. Iocaste hanged herself.)

Jupiter XXV ERINOME (Ερινομη)

Daughter of Celes, who was compelled by Venus to fall in love with Jupiter but lost her virginity to Adonis, who then was struck by lightning thrown by Jupiter.

Servius: Commentarius in Vergilii Bucolicon Librum 10,18:

Celes (...) who had a daughter Eurinome (...). Being loved by Minerva due to her great chastity she, on the other hand, invisibly was pressed by Venus. In order to corrupt the chastity of the girl she compelled her to fall in love with Jupiter. Having seen through this craft Juno, in order to combat the craft and treachery, sought Venus's aid to inflame Adonis with love to the girl. He, however, was not able by any craft to gain her love. Now Venus threw a fog on her, and in fog Adonis succeeded in penetrating the virgin. Thus by violence and deception the girl lost her virginity. But as a result the unhappy Diana transformed this girl into a peacock. This happened close to River Cisseus. As soon as Adonis realized that he had assaulted a love affair of Jupiter he fled into the woods of the Casius mountains to live there in the wilderness together with beasts. Using all the tricks of the trade Mercury succeeded to drive him out there while he was pursuing a boar which is said to be Mars in the fables. Adonis while being on the point of defeating him in a violent fight suddenly was struck by lightning thrown by Jupiter and was killed.

Jupiter XXVI ISONOE (Ισονοη)

A Danaid, and mother of Orchomenus by Zeus.

Scholia in Apollonium Rhodium Vetera 1,230:

After having intercourse with Zeus the Danaid Isonoe gave birth to Orchomenos; the town Orchomenos [in Arcadia] is named after him.

Apollodorus: Bibliotheca 2,1,5:

(The Danaids:) When they had got their brides by lot, Danaus made a feast and gave his daughters daggers; and they slew their bridegrooms as they slept, all but Hypermnaestra; for they saved Lynceus because he had respected her virginity: wherefore Danaus shut her up and kept her under ward. But the rest of the daughters of Danaus buried the heads of their bridegrooms in Lerna and paid funeral honours to their bodies in front of the city; and Athena and Hermes purified them at the command of Zeus. Danaus afterwards united Hypermnaestra to Lynceus; and bestowed his other daughters on the victors in an athletic contest.

Jupiter XXVII PRAXIDIKE (Πραξιδικη)

A divine exacter of Justice; mother of Klesios, Harmonia and Arete by Zeus.

Suidas: Lexicon Graece et Latine:

Praxidike: a goddess who is sculpted only with her head. Mnaseas in his book on the Europa writes that Sother (Zeus) had from Praxidike his son Klesios, as also the sisters Harmonia and Arete, called the Praxidikai.

Hesychius: Lexicon:

Praxidike: She is, they say, a certain goddess, who embodies the greatest fulfilment in favour of all those who are speaking as also in favour of those who are acting. Therefore her statues are represented as heads like the offerings to her.

Pausanias 3 (Laconia), 22,2 and 9,33,3:

(West Laconia:) When Menelaus had taken Ilium and had returned safe home eight years after the sack of Troy, he set up near the sanctuary of Migonitis an image of Thetis and the goddesses Praxidicae, the Exacters of Justice.

(Central Boeotia:) At Haliartus there is in the open a sanctuary of the goddesses they call Praxidicae, "those exact punishments". Here they swear, but they do not make the oath rashly. The sanctuary of the goddesses is near Mount Tilphusius.

Jupiter XXVIII AUTONOE (ΑΥΤΟΝΟΗ)

Mother of the Graces by Jupiter according to some authors.

Lactantius: Scholia in Statium Thebais 2,286:

Pasithea is one of the Graces/Charites; there are three of them: Pasithea, Aglaia, Euphrosyne, daughters of Jupiter and Autonoe.

Pindarus: Carmina Pythica 9,59–65:

(In Libya, Kyrene) shall bear a son, whom glorious Hermes shall take from his mother's womb and bear away to the enthroned Hora (Season) and to Gaia; and they shall place the babe upon their laps, and drop nectar and ambrosia on his lips, and

shall ordain that, as a delight to his friends among men, he shall be called immortal Zeus (...) while others shall name him Aristaios.

Diodorus Siculus 4,81,3:

After this, they say, Aristaios went to Boeotia where he married one of the daughters of Kadmos, Autonoe, to whom was born Aktaion, who, as the myths relate, was torn to pieces by his own dogs.

(Idem *Apollodorus 3,4,4:* In Arkadia, Zeus was worshipped as Aristaios.)

Jupiter XXIX THYONE (Θυωνη)

Mother of Dionysos by Zeus, originally named Semele. She received the name of Thyone when her son ascended with her from Hades to heaven.

Ioannes Laurentius Lydus: De Mensibus 4(Martius),51:

According to the poets there are five Dionysi: the first is the son of Zeus and Lysithea, the second is the son of Nilos (Nile), who reigned over Libya, Ethiopia and Arabia and was named after the Kabiran rite, the fourth is the son of Zeus and Semele, to whom the mystery of Orpheus was celebrated and by whom the wine was mixed, and the fifth is the son of Nisos and Thyone, who introduced the triennial Trieterid festival. This is being told by the Greeks.

Cicero: De Natura Deorum 3,58:

We have a number of Dionysi (...) The fifth is the son of Nisos and Thyone, and is believed to have established the Trieterid festival.

Apollodorus: Bibliotheca 3,5,2-3,

see Jupiter X LYSITHEA.

Jupiter XXX HERMIPPE (Ερμιππη)

Lover of Zeus, and mother of Orchomenos by him.

Scholia in Homeri Iliadem B(2),511:

There are two cities named Orchomenos, the one is in Arcadia, the other in Boeotia. (...) Orchomenos in Boeotia was reigned by Minyos as a king, named after Orchomenos the son of Zeus and Hermippe the daughter of Boiotos. River Minyas flows past on it (the city), after which the inhabitants of the country were given the name of Minyai.

Jupiter XXXI AITNE (Αἰτνη/Aetna)

A Sicilian nymph whom Zeus mated as a vulture.

Stephanus Byzantius: Ethnica:

Palice, Sicilian town. (...) The area of the divine Palikoi whose genealogy first of all is given by Aischylos in his *Aitnaiai*. There they are the sons of Zeus and Thaleia, the daughter of Hephaistos. According to Silenos the Palkoi are the sons of Aitne, the daughter of Okeanos and Hephaistos.

Servius: Vergilii Aeneis 9,581:

Jupiter had raped the nymph Aetna or, as some say, Thalia, and had made her pregnant. Being frightened of Juno he entrusted Terra with the young lady. Later two boys rose out of the ground, then named the Palici.

Clemens Romanus: Recognitiones (transl. Rufinus) 10,20.22:

Graciously ignoring the other gods I shall report on the one whose offences are worst, namely the shameful deeds committed by Jupiter. (One of the conquests whom he made pregnant in the likeness of an animal was) Aetna, a nymph. He mated with her as a vulture.

Le Premier Mythographe du Vatican, ed. Nevio Zorzetti 2,88:

Jupiter raped the nymph Aetna and made her pregnant. Being frightened of Juno he entrusted Terra with the young lady, as some say. According to others she later entrusted to Terra the fruit of her pregnancy.

Scholia in Theocritum Vetera 1,65; Poetae Lyrici Graeci ed. Th. Bergk, vol. 3, frg. 200 B:

Mount Aetna in Sicily is named after Aitne, the daughter of Uranos and Ge, according to Alkimos. Simonides in his treatise on Sicily says that Aitne served as an arbitrator in the struggle between Hephaistos and Demeter for the possession of Sicily.

Jupiter XXXII EURYDOME (Ευρυδομη)

She or (according to others) Eurynome was the mother of the Graces by Zeus.

Cornutus: Theologiae Graecae Compendium 15:

It is right and proper, they say, to be charitable, and therefore it is mostly tradition that the Charites (Graces) are daughters of Zeus; some say they were born by Eurydome ('the broad-housing') for it is mostly in the habit of giving presents from broad extending houses. According to others, they were born by Eurynome ('the one with the broad meadows') for the components of this name are obviously derived from the fact that those who run large landed properties somehow are more gen-

erous. According to others, they were born by Euromedusa ('the one who is ruling over a wide area'); the derivation is similar, for all men have their property at their disposal (they cannot give as a present but their possession—therefore large property is a good qualification for generosity).

Jupiter XXXIII EUANTHE (Ευανθη)

One of the different names in mythology for the mother of the Graces by Zeus (see also Jupiter XXXII: Eurydome).

Cornutus: Theologiae Graecae Compendium 15:

In particular one (of the Charites/Graces) is named Aglai ('shine'), a second one Thaleia ('bloom'), the third Euphrosyne ('cheerfulness'), and some say Euanthe ('beautiful in bosom') is their mother, others say that Aigle ('shine') is their mother. Homer, however, says that one of the Graces lived together with Hephaistos, for the works of art are filled with grace.

Jupiter XXXIV EUPORIE

One of the Horae (Seasons), daughters of Jupiter and Themis.

Hyginus: Fabula 183:

Moreover there are the Horae (Seasons), daughters of Saturn's son Jupiter and the Titanic daughter Themis: Auxo, Eunomia, Pherusa, Carpo, Dike, Euporie ('Plenty'), Irene, Orthosie ('Luck'), Thalla. With others it is a tradition to mention the names of ten of them: Auge, Anatole, Musica, Gymnastica, Nymphe, Mesembria, Sponde ('Peace'), Eleacte, Hesperis, Dysis.

Nonnus: Dionysiaca 9,13–14; Hesiodus: Opera et Dies 74–75:

(The Horae, daughters of Zeus, were present at the birth of Dionysos:)

The childbed Horae crowned him with an ivy-garland in presage of things to come; they wreathed the horned head of a bullshaped Dionysos with twining horned snakes under the flowers. (And they were present at the creation of Pandora:) The rich-haired Horae crowned her head with spring flowers.

Jupiter XXXV ORTHOSIE

One of the Horae (Seasons), daughters of Jupiter and Themis.

Hyginus: Fabula 183 etc.,

see Jupiter XXXIV EUPORIE.

Jupiter XXXVI SPONDE (Σπονδη)

One of the Horae (Seasons), daughters of Jupiter and Themis.

Hyginus: Fabula 183 etc.,

see Jupiter XXXIV EUPORIE.

Jupiter XXXVII KALE (Καλη)

One of the Graces, a daughter of Zeus, wife of Hephaistos.

Sostratos, in: Eusthatus: Commentarii in Homeri Odyseam K(10),492:

Teiresias the seer was staying at the wedding of Thetis and Peleus. There Aphrodite contended for the attraction with the Charites (Graces) whose names are Pasithee ('Kind to everybody'), Kale ('Beautiful'), and Euphrosyne. After having settled the dispute he (Teiresias) pronounced sentence that Kale was beautiful—Kale whom Hephaistos then married. Therefore Aphrodite with rage had transformed him (Teiresias) into an old poor female day labourer. Kale, however, offered her (Aphrodite) her beautiful hair as sacrifice and then went to Crete. There Arachnos fired with longing for her (Kale), and after having had sexual intercourse with her he prided himself on having had intercourse with Aphrodite. Being angry with this the goddess (Aphrodite) transformed Arachnos into a weasel. Teiresias, however, into a mouse. Therefore they say that the mouse only eats a little, because she originated from an old woman, and that it (the mouse generally) is prophesying because of Teiresias.

Julianus, in: Anthologia Graecae 12,599:

She is dead, Kale ('Beautiful') by name and more so (beautiful) in mind than in face. Alas! the spring of the Graces has perished utterly. For very like was she to Aphrodite, but only for her lord; for others she was an unassailable Pallas. What stone did not mourn when the strong hand of Hades tore her from her husband's arms.

Jupiter XXXVIII PASITHEE (Πασιθεη)

One of the Graces, daughters of Zeus; wife of Hypnos.

Sostratos, in: Eusthatus: Commentarii in Homeri Odyseam K(19),492

see Jupiter XXXVII KALE.

Homerus: Ilias 14,267–269:

Ox-eyed queenly Hera spoke to Hypnos/Sleep:) "Do you think Zeus will aid the Trojans in the same way as he was angry over Herakles, his own son? But come, I will give you one of the youthful Charites (Graces) to wed and to be called your wife,

Pasithee, for whom you have been longing all your days.” So she spoke, and Hypnos rejoiced and answered: “Come now swear to me (...) that you truly will give me one of the youthful Graces, Pasithee, for whom I have been longing all my days.”

Jupiter XXXIX HEGEMONE (Ηγεμونه)

One of the Graces, daughters of Zeus.

Pausanias 9,35,1–2:

The Boeotians say that Eteokles was the first man to sacrifice to the Charites (Graces). Moreover, they are aware that he established three as the number of the Charites, but they have no tradition of the names he gave them. The Lakedaemonians, however, say that the Charites are two, and that they were instituted by Lakedaemon, son of Taygete, who gave them the names of Kleta and Phaenna. These are appropriate names for Charites, as are those given by the Athenians, who from of old have worshipped two Charites, Auxo and Hegemone.

Iulius Pollux: Onomasticon H(8),106:

(In Athens, the Grace Hegemone [‘female leader’] was so important that she was called as witness in an oath to be sworn in the temple of Agraulos, daughter of Kekrops:)

I will not disgrace the arms (...) I will fight alone or together with others against each one who cancels the laws or doesn’t obey them. And I will venerate the paternal sanctuaries. Witnesses are you the gods: Agraulos, Enyalios, Ares, Zeus, Thallo, Auxo, Hegemone.

Tod MN (ed) (1948) A Selection of Greek Historical Inscriptions, vol. II. OUP, Oxford, p. 204:

(The above oath is engraved also on a marble stele with a pediment, on which is represented in relief the defensive armour of a hoplite. It is the Oath of Athenian Ephoroi and Oath of Athenians before the Battle of Plataia, fourth century B.C.): “Witnesses are you the gods: Agraulos, Ares, Zeus, Thallo, Auxo, Hegemone, Herakles. (...)”

Jupiter XL MNEME (Μνημη)

One of the Muses, daughters of Zeus.

Hesiodus: Theogonia 36–46:

Come thou, let us begin with the Muses who gladden the great spirit of their father Zeus in Olympus with their songs, telling of things that are and that shall be and that were aforetime with consenting voice. Unwearing flows the sweet sound from their lips, and the house of their father.

Zeus the loud-thunderer is glad at the lily-like voice of the goddesses as it spreads abroad, and the peaks of Snowy Olympus resound, and the homes of the immortals. And they uttering their immortal voice, celebrate in song first of all the reverend race of the gods from the beginning, those whom Earth and wide heaven begot, and the gods sprung of these, givers of good things.

Pausanias 9 (Boeotia), 29,2:

The sons of Aloeus held that the Muses were three in number and gave them the names of Melete ('Practice'), Mneme ('Memory') and Aoede ('Song'). But they say that afterwards Pierus, a Macedonian, after whom the mountain in Macedonia was named, came to Thespieae and established nine Muses, changing their names to the present ones.

Terpander, in: Poetae Lyrici Graeci, ed. Th. Bergk, Oxford University, 3,3,3:

We offer a sacrifice to Mnemes, to all Muses and to the leader of the Muses (Apollon), the son of Leto.

Plutarchus: Euthydemus 275 D:

Kriton asks Sokrates to give an account of his conversation with the sophist Euthydemus and a young pupil Kleinas. He answers:)

What ensued, Kriton, how am I to relate in proper style? For no slight matter it is to be able to recall in description such enormous knowledge as theirs. Consequently, like the poets, I must needs begin my narrative with an invocation of the Muses and Mneme ('Memory'). Well, Euthydemus, set to work, so far as I remember, in terms very much the same as these: Kleinas, which sort of men are the learners, the wise or the foolish?

At this the young man, feeling the embarrassment of the question, blushed and glanced at me in his helplessness. (...)

Jupiter XLI AOEDE (Αοιδη)

One of the Muses, daughters of Zeus.

Hesiodus: Theogonia 36–46:

Come thou, let us begin with the Muses who gladden the great spirit of their father Zeus in Olympus with their songs, telling of things that are and that shall be and that were aforetime with consenting voice. Unwearing flows the sweet sound from their lips, and the house of their father.

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Cicero: De Natura Deorum 3,54 (like Aratus, in: Tzetzes in Hesiodi Opera, ed. W. Gaisford, p. 28):

Again, the first set of Muses are four, the daughters of the second Jupiter, Thelxinoe ('Charm'), Aoede ('Song'), Arche ('Beginning') and Melete ('Practice'); the second set are the offspring of the third Jupiter and Mnemosyne, nine in number.

Anecdota Graeca, ed. J. Cramer, G. Olms, 4,424–425:

Cod. Barocc. 133: According to oral tradition the Corinthian Eumolos was of the opinion that three Muses were the daughters of Apollo: Kephisus, Apollinis, Borys-thenes. Aratus in the fifth canto of his poem on celestial phenomena reports that four Muses were the daughters of Zeus Aetherus and the nymph Plusia: Arche, Melete, Thelxione and Aoide.

Jupiter XLII THELXINOE (Θελξινοη)

One of the Muses, daughters of Zeus.

Hesiodus: Theogonia 36–46 and Pausanias 9,29,2,

see Jupiter XLI AOEDE.

Cicero: De Natura Deorum 3,54 and Anecdota Graeca 4,424–425,

see Jupiter XLI AOEDE.

Tzetzes: Scholia in Hesiodi Opera 1,23:

The names of the nine Muses are Kallichore, Helike, Eunike, Thelxinoe, Terpsichore, Euterpe, Eukelade, Dia, Enope.

Jupiter XLIII ARCHE (Αρχη)

One of the Muses, daughters of Zeus.

Hesiodus: Theogonia 36–46,

see Jupiter XLI AOEDE.

Cicero: De Natura Deorum 3,54 and Anecdota Graeca 4,424–425,

see Jupiter XLI AOEDE.

Jupiter XLIV KALLICHORE (Καλλιχορη)

One of the Muses, daughters of Zeus.

Hesiodus: Theogonia 36–46,

see Jupiter XLI AOEDE.

Tzetzes: Scholia in Hesiodi Opera 1,23,

see Jupiter XLII THELXINOE.

Nonnus: Dionysiaca 14,213–222:

(Combatants of Dionysos in his Indian War: the nymphs ...) Stronger than these came the nurses of Dionysos, troops of Bassarids well skilled in their art: Aigle and Kallichore ('beautiful in dance').

Jupiter XLV HELIKE (Ἑλική)

One of the Muses, daughters of Zeus.

Hesiodus: Theogonia 36–46,

see Jupiter XLI AOEDE.

Tzetzes: Scholia in Hesiodi Opera 1,23,

see Jupiter XLII THELXINOE.

(Helike is also the name of an Idaean nymph who, together with Kynosura, nursed Zeus in a grotto of Ida, and as a reward was transferred to the stars. *Philostephanus, in: Scholia in Pindari Carmina, Scholia in Olympicones 6,144.*)

Nonnos: Dionysiaca 25,403–410.

(Between the two heavenly waggons Hephaistos) made the Serpent, which is close by and joins the two separate bodies, bending his heavenly belly in spiral shape and turning to and from his speckled body, like the spirals of Maiandros and its curving murmuring waters, as it runs to and from in twists and turns over the ground: the Serpent keeps his eye ever fixed on the head of Helike (Great Bear), while his body is girdled with starry scales.

Jupiter XLVI CARPO (Καρπω)

One of the Horae; a daughter of Zeus.

Hyginus: Fabula 183,4:

Moreover there are the Horae (Seasons), daughters of Saturn's son Jupiter and the Titanic daughter Themis: Auxo, Eunomia, Pherusa, Carpo, Dice, Euporie, Irene, Orthosie, Thallo.

Pausanias 9 (Boeotia), 35,2:

(...) the Athenians, who from of old have worshipped two Charites (Graces), Auxo and Hegemone. Karpo ('harvest') is the name, not of a Charis, but of a Hora (Season). The other Hora is worshipped together with Pandrosos (son of Kekrops) by the Athenians, who call the goddess Thallo.

Jupiter XLVII EUKELADE (Ευκελαδη)

One of the Muses, daughters of Zeus.

Tzetzes: Scholia in Hesiodi Opera 1,23:

The names of the nine Muses are Kallichore, Helike, Eunike, Thelxinoe, Terpsichore, Euterpe, Eukelade ('well sounding'), Dia, Enope ('in good voice').

Jupiter XLVIII CYLLENE (Κυλληνη)

A nymph; daughter of Zeus.

Scholia in Euripidem, Rhesus 36:

They say that (Kyllene and other nymphs) were the children of Kallisto and Zeus, after her the mountain is called Kyllene. (...) Eumenides (frg. 12), however, says that Pan and Arkas were twin brothers born by Kallisto to Zeus.

Stephanus Byzanthius: Ethnica:

Kyllene, mountain in Arkadia, nine stadia minus 80 feet high (i.e., 1702 m, in reality 2374 m). Named after the nymph Kyllene daughter of Nais. On this mountain, but never elsewhere, they say, the blackbirds become white, and they produce diverse singing. They are chased in the moonlight, during the day, however, for everybody who would try it, it is impossible to shoot them.

Ovidius: Metamorphoses 7,384–388:

And next Medea saw the fertile island of Calauria, sacred to Latona, the island that knew the king and his wife both changed into birds. On her right lies Cyllene, which Menephron was doomed to defile with incest after the wild beasts' fashion.

Hyginus: Fabula 253:

Those who had contacts in contrast with morality: Menephron with Cyllene, in Arcadia, and with his mother Blias.

Apollodorus: Bibliotheca 8,1:

Let us now return to Pelasgos, who, Akusilaos says, was a son of Zeus and Niobe, as we have supposed, but Hesiod declares him to have been a son of the soil. He had a son Lykaon by Meliboia, daughter of Ocean or, as others say, by a nymph Kyllene.

Johannes Tzetzes: Scholia ad Lycophronem 481:

Pelasgos was the son of Zeus and Niobe. He had a son Lykaon by the maiden Meliboia or, as others say, by the nymph Kyllene.

Jupiter XLIX KORE (Κορη)

Daughter of Zeus and Demeter; as the wife of Hades she received the name Persephone.

Orphicorum Fragmenta 198:

[Kore (“Maiden”), the daughter of Zeus and Demeter, was raped by Pluto, and as his wife she received the name of Persephone:]

Proklos, in *Theologia Platonis* 6, 11, p. 370, says: “The order of Kore is twofold, the first made manifest in the supramundane sphere, where as we hear she is linked with Zeus, and together with him brings forth the one creator of the divided world (i.e. Dionysos), the second within the world, and this is the Kore who is said to be carried off by Pluto.”

Orphicorum Fragmenta 195:

Proklos on Plato’s *Cratylus* 402 d: “Therefore the *theologos* says that the two extreme gods (i.e. Jovis, god of the upper world, and Pluto of the lower) create with Kore the first things and the lasts, but the middle god (i.e., Neptune) even without her. (...) For this reason they say that Kore is now violated by Zeus, now carried off by Pluto. (...) For indeed the word of the *theologoi* who have handed down to us the holy mysteries at Eleusis says that Kore lives in the first place above, where she stays in her mother’s house, which her mother prepared for her in a remote place removed from the world, and in the second place below, where she rules with Pluto over those of the underworld.”



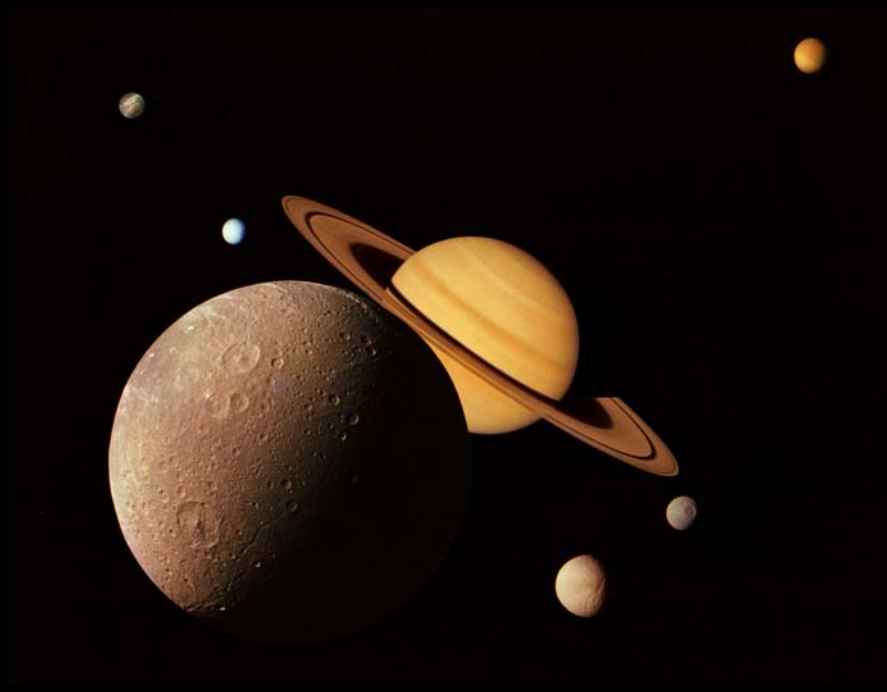
Kore in the Lower World

Plutarchus: Aristidis Vita 11,3–6:

Aristides sent to Delphi and received from the god responses that the Athenians would be superior to their foes if they made vows to Zeus, Citheronian Hera, Pan, and the Sphragite nymphs; paid sacrifices to the heroes (...); and if they sustained the peril of battle on their own soil, in the plain of Eleusinian Demeter and Kore. When this oracle was reported to Aristides, it perplexed him greatly. (...) Arimnestus discovered that near Hysiae, at the foot of Mount Kithairon, there was a very ancient temple bearing the names of Eleusinian Demeter and Kore. Straightaway then he took Aristides and led him to the spot.

Photograph on opposite page: Saturn and some of its satellites. Copyright NASA

The Satellites of Saturn



The Satellites and Rings of Saturn

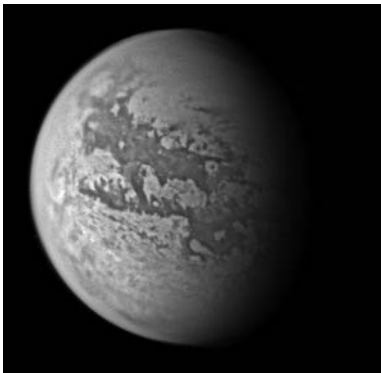
Discovering and Naming the Satellites

On 25 March 1655, using a refractor that he designed and which provided a magnitude of 50, Christiaan Huygens (1629–1695) discovered the largest satellite of Saturn, which he simply called Luna Saturni but was later named Titan.

In 1671 Jean-Dominique Cassini (1677–1756) discovered two other moons of Saturn, Iapetus on October 25, 1671, and Rhea on December 23, 1672, using his 40-meter-long refractor at Paris Observatory, and he correctly stated that the first had light and dark sides, and that it always kept the same face turned towards Saturn. On March 21, 1672 he discovered Rhea, and in 1684 the two Saturnian moons later named Tethys and Dione. Cassini named the four moons he discovered *Sidera Lodoicea* (“the stars of Louis”) in order to honor king Louis XIV. He wrote (*Mémoires de l’Académie des Sciences*, 10, 494):

The satellites of Saturn, still more grand and more difficult to discover (than the *Sidera Medicaea* of Galileo) are not unworthy of bearing the name of Louis the Grand (Louis XIV), since they have been discovered under the glorious reign of his majesty and because of the extraordinary assistance furnished to astronomers at his observatory at Paris. We may justly call them the Louisian Stars (*Sidera Lodoicea*).

In order to distinguish them from the previously known moons of Saturn, Cassini denominated them according to their distances from the planet, the innermost be-



View of Titan, taken by Cassini's optical cameras on March 31, 2005 at a distance of 2402 km. Copyright NASA/JPL/Space Science Institute

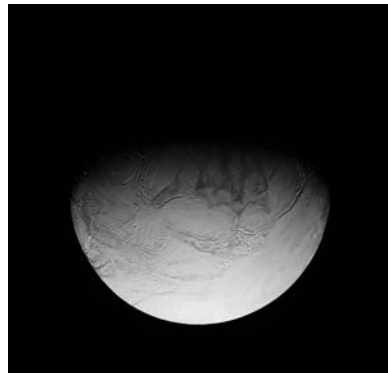


Image of Enceladus taken by the camera on the Cassini spacecraft on March 12, 2008. Copyright NASA/JPL/Space Science Institute

ing the first moon. Consequently, the moon discovered by Huygens, although it was discovered first, was designated the fourth moon.

On the August 28, 1789, William Herschel (1738–1822) discovered the sixth moon (later named Enceladus) with his 40-foot reflector at Slough, and then, on the 17th of the following month, he spotted the seventh satellite (later named Mimas).

From the end of the seventeenth century until 1789, the other satellites were designated by the Roman numerals I through V according to the sequence of the orbits around the planet (Tethys, Dione, Rhea, Titan, Iapetus). The numbering scheme was then extended to Saturn VII (with the series now: Mimas, Enceladus, Tethys, Dione, Rhea, Titan). The discovery of Hyperion in 1848 changed the numbering for a last time, designating Iapetus as Saturn VIII.



False-color image of Hyperion obtained with different spectral filters by the Cassini spacecraft's narrow-angle camera at a distance of 618 km on September 26, 2005. Copyright NASA/JPL/Space Science Institute

The names of the first seven satellites come from William Herschel's son John in his 1847 publication *Results of Astronomical Observations made at the Cape of Good Hope* (Smith, Elder, Co., London, p. 415), in which he suggested that the names of the Titans, sisters and brothers of Kronos/Saturn, should be used:

I have used for my own convenience, and shall continue to do so in what follows a mythological nomenclature, which, however, I do not presume to recommend to the adoption of others, though I am persuaded that *some* nomenclature other than the equivocal one in actual use, will be found necessary by all who observe these bodies.

He also commented:

As Saturn devoured his children, his family could not be assembled round him, so that the choice lay among his brothers and sisters, the Titans and Titanesses. The name Iapetus seemed indicated by the obscurity and remoteness of the exterior satellite, Titan by the superior size of the Huygenian, while the three female appellatives class together the three intermediate Cassinian satellites. The

minute interior ones seemed appropriately characterized by a return to male appellatives, chosen from the younger and inferior (though still super-human) brood. Should an eighth satellite exist, the confusion of the old nomenclature will become quite intolerable.

The spelling of Enceladus shows that Herschel kept to the traditional custom of using the relevant Roman designation. However, in the case of Rhea, he chose the Greek version instead of Ops, perhaps because it sounded better.

As a memory aid for the sequence of names of the Titans and giants assigned to the satellites of Saturn, he offered a verse, a pentameter with hemiepes, to the readers of his *Outlines of Astronomy* (1849, p. 336 f.):

Iapetus, Titan, Rhea, Dione, Tethys
Enceladus, Mimas _____.

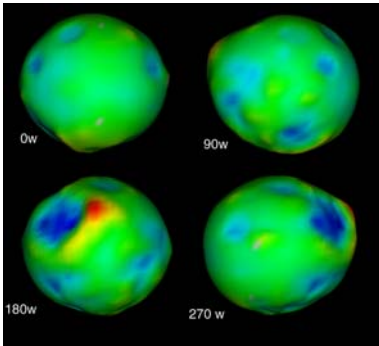
Saturn VII was discovered by William Cranch Bond (1789–1859) and his son George Phillips Bond with the 15-inch refractor of the Harvard College Observatory at Cambridge, MA, USA, on September 16, 1848, and simultaneously by William Lassell (1799–1880) with his 61-cm reflector at Starfield near Liverpool. This came shortly after John Herschel had suggested names for the previously known satellites of Saturn in his 1847 publication, which influenced Lassell to name the moon Hyperion in order to minimize the confusion caused by the new numbering scheme mentioned above. In 1848, in the *Monthly Notices of the Royal Astronomical Society* (8, 3, 42), Lassell writes on John Herschel's nomenclature, published in his *Cape Observations*: "I cannot but think this nomenclature a great improvement, and worthy of general adoption." In 1858, in a new edition of his *Outlines of Astronomy*, (Longman et al., London, p. 367), John Herschel comments in greater depth on the old designations of seven satellites with numbers:

This confusion, which the introduction of an eighth would have rendered intolerable, has been obviated by a mythological nomenclature, suggested in a former edition of this work, and which has been generally accepted, in consonance with that at length completely established for the primary planets. Taking the names of the Titanian divinities, the following verses, pardoning false quantities) afford an easy artificial memory [now a distich with hemiepes]:

Iapetus cunctos supra rotat, hunc sequuntur
Hyperion, Titan, Rhea, Dione, Tethys,
Enceladus, Mimas _____".

On August 16, 1898, William Henry Pickering (1858–1938) discovered Saturn IX with the Bruce 24-inch refractor in his observatory near Arequipa in Peru. He suggested that the name Phoebe be given to the new satellite (*Annals of the Astronomical Observatory of Harvard College*, 53, 3, 45): "Phoebe, being, according to the ancient mythology, a sister of Saturn. Three satellites, Thetys, Dione, and Rhea, had been already named for his sisters, and two, Hyperion and Iapetus, for his brothers."

In 1905 W.H. Pickering claimed to have discovered a tenth satellite (orbiting between the orbits of Titan and Hyperion), which was, however, never confirmed. He



A digitally rendered model of the shape of Phoebe from Cassini imaging data obtained before and after the spacecraft's flyby on June 11, 2004. Copyright NASA/JPL/Space Science Institute

wrote in the *Annals of the Astronomical Observatory of Harvard College* (53, 9, 174) on its name: "A name has been selected from among those of the sisters of Saturn, as in the case of Phoebe, and it has been decided to call the new satellite Themis." Oddly enough, Hermann Goldschmidt (1802–1866) announced in 1961 that he had discovered a new satellite of Saturn at Paris Observatory that was orbiting between Titan and Hyperion (just like Themis), which he named Chiron (the centaur and son of Kronos). This Chiron was also never confirmed.

Following the discovery of Phoebe but before further discoveries, the sequence of satellite names with increasing distance from Saturn was easily remembered using the simple mnemonic *Met Dr. Thip*; that is, Mimas, Enceladus, Tethys, Dione, Rhea, Titan, Hyperion, Iapetus, Phoebe (1981, *Sky and Telescope*, 61, 126).

Using the refracting telescope of the Pic du Midi, it was Audouin Dollfus who discovered a further satellite of Saturn on December 15, 1966, for which on February 1, 1967 he then proposed the name of Janus (*IAU Circular*, 1995). On December 18, 1966, Stephen Larson, John Fountain and Richard L. Walker made a similar observation in photographs taken with the 61-inch Catalina reflector at the University of Arizona, and they are now credited with the discovery of Epimetheus. Later, Stephen M. Larson and John Fountain realized that the 1966 observations were best explained by two distinct objects (Saturn X Janus and Saturn XI Epimetheus) that have very similar orbits (1978, *Icarus*, 36, 92–106). The existence of co-orbital satellites was confirmed in 1980 by the Voyager 1 probe.

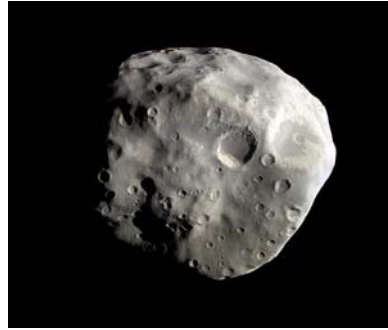
On March 1, 1980, B. Laques, J. Lecacheux et al. discovered a co-orbital moon of Dione (named Dione B), using the 1-m telescope at Pic du Midi. It was provisionally designated S/1980 S 6. It was also designated Saturn XII Dione B in 1982, and named Helene in 1988.

On April 8, 1980, Brad Smith, S. Larson and Harold J. Reitsema discovered a moon co-orbital with Tethys that was provisionally designated S/1980 S 13 and also designated Saturn XIII Tethys B, before being named Telesto in 1982. They used the 1.5-m telescope of the Catalina Observatory at the University of Arizona, Tucson, AZ, as well as a coronagraphic imaging system with charge-coupled devices.

On August 13, 1980 another moon co-orbital with Tethys was discovered by Dan Pascu, P. Kenneth Seidelmann, William Baum and Douglas Currie using the 1.5-m



Close-up view of Janus, snapped by the Cassini spacecraft on February 20, 2008. Copyright NASA/JPL/Space Science Institute



View of the south polar region of Epimetheus, taken with the Cassini spacecraft's narrow-angle camera on December 3, 2007. Copyright NASA/JPL/Space Science Institute

astrometric reflector of the U.S. Naval Observatory in Flagstaff, and was provisionally designated S/1980 S 25. It was also designated Saturn XIV Tethys C and named Calypso in 1982.

Around 1980/81, further satellites of Saturn were discovered on photos taken by the Voyager probes. S/1980 S 26, an outer shepherd for the F Ring, was discovered by S.A. Collins on Voyager 1 frames. It was designated Saturn XVII and named Pandora in 1985.

S/1980 S 27, an inner shepherd for the F Ring, was discovered in October 1980 by S.A. Collins while studying Voyager 1 photos. It was designated Saturn XVI and named Prometheus in 1985. The names Calypso, Epimetheus, and Telesto were approved by the General Assembly of the IAU in 1982 (*Transactions of the IAU*, 18B, 336), and the names Helene, Pandora, and Prometheus by the General Assembly of the IAU in 1985 (*Transactions of the IAU*, 19B, 350).

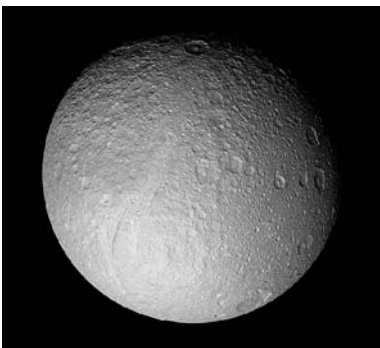


Image of Tethys taken during Cassini's close approach to the moon on September 24, 2005. Copyright NASA/JPL/Space Science Institute



View of Calypso, taken with the Cassini spacecraft's narrow-angle camera on September 23, 2005. Copyright NASA/JPL/Space Science Institute

S/1980 S 28, an outer shepherd for the A Ring, was discovered in October 1980 by Richard Terrile on Voyager 1 photos. It was designated Saturn XV and named Atlas in 1983 (the names Atlas and Janus were accepted by the IAU Executive Committee in September 1983: *IAU Circular*, 3872).

While analyzing images of Saturn taken by Voyager 2, Mark Showalter of NASA's Ames Research Center was able, as reported on July 16, 1990, to identify the predicted satellite designated S/1981 S 13, which orbits in the Encke Division of Saturn's rings. It was designated Saturn XVIII and named Pan, a name which was approved by the General Assembly of the IAU in 1991 (*Transactions of the IAU*, 22B, 393).

In the year 2000 our knowledge of Saturn was enhanced by the discovery of twelve new satellites via ground-based observations.

The first three of them were discovered on August 7 by Brett J. Gladman, John J. Kavelaars, Jean-Marc Petit, Hans Scholl, Matthew J. Holman, Brian Marsden, Philip D. Nicholson, and Joseph A. Burns at the European Southern Observatory in La Silla, Chile:

- S/2000 S 1, later named Saturn XIX Ymir
- S/2000 S 2, later named Saturn XX Paaliaq
- S/2000 S 5, later named Saturn XXIV Kiviuq

Another eight of them were discovered on September 23 by Brett J. Gladman, John J. Kavelaars, Jean-Marc Petit, Hans Scholl, Matthew J. Holman, Brian Marsden, Philip D. Nicholson, and Joseph A. Burns using the 3.6-m Canada–France–Hawaii reflector on Mauna Kea, Hawaii, with adaptive optics:

- S/2000 S 3, later named Saturn XXIX Siarnaq
- S/2000 S 4, later named Saturn XXI Tarvos
- S/2000 S 6, later named Saturn XXII Ijiraq
- S/2000 S 7, later named Saturn XXX Thrymr
- S/2000 S 8, later named Saturn XXVII Skathi
- S/2000 S 9, later named Saturn XXX Mundilfari
- S/2000 S 10, later named Saturn XXVIII Erriapo (changed to Erriapus in December 2007)
- S/2000 S 12, later named Saturn XXXIII Suttungr

The twelfth was discovered on November 9 by Matthew J. Holman with the 6.2-m reflector at the F.L. Whipple Observatory, Mt. Hopkins:

- S/2000 S 11, later named Saturn XXVI Albiorix

Most of the newly discovered satellites were irregular satellites. The discoverers agreed that the names of these satellites should deviate unambiguously from the traditional names of satellites. Above all it was J.J. Kavelaars, an astronomer at McMaster University in Hamilton, Canada, who, following his own information, attempted to help astronomical nomenclature to find its way out of its Greco–Romano–Renaissance rut. He spent several months trying to find names that were both multicultural and Canadian. He consulted American scholars without finding a name for S/2000 S 6 that seemed appropriate. In March 2001, he was reading an Inuit tale to his children

(1994, *Hide and Sneak*. Annick, Toronto) and had a revelation. In this tale, the Ijiraq plays hide-and-seek, which is what these small moons of Saturn do: they are hard to find, and could like the Canadian Arctic (the team of discoverers include Canadians, Norwegians and Icelanders—Nordicity is their common trait). Kavelaars contacted the author of the tale, Michael Avaarluk Kusugak, to get his permission, and the latter also suggested the names Kiviuiq, Paaliac and Siarnaq. While Ijiraq and Paaliac are fictional names created by Kusugak (a humanoid creature in a children book and a fictional shaman in a manuscript last published in 2006: *The Curse of the Shaman*, Harper Trophy, Toronto), Kiviuiq is a well known Inuit hero and Siarnaq is an Inuit goddess of the sea who can be identified with Sedna, a name that Kusugak had already successfully suggested for the Trans-Neptunian Object 90377 Sedna.

These four Inuit names were assigned to the “Inuit group” of newly discovered satellites. The IAU reserves names taken from the Inuit folklore and mythology for moons with retrograde orbits, semi-major axes ranging from 11 to 18 Gm, inclinations of between 40° and 50° , and eccentricities of between 0.15 and 0.48.

Similarly, the IAU reserves names taken from Gallic mythology for moons whose semi-major axes range between 16 and 19 Gm, whose inclinations are between 40° and 45° , and whose eccentricities are around 0.53. The discoverers believe that there is a common origin for the Gallic group: they derive from a larger body that was broken up.

In the same way, the IAU reserves names taken from Norse mythology (mostly giants) for the large group of retrograde irregular satellites whose semi-major axes range between 12 and 24 Gm, inclinations of between 136° and 175° , and eccentricities of between 0.13 and 0.77. This Norse group of satellites also comprises Phoebe, the largest, which was discovered long before the others.

In this way, all of the Saturnian satellites discovered in 2000 were officially named by the 25th General Assembly of the IAU in Sydney in 2003.

On April 8 of that year, a further satellite of Saturn was discovered by Scott S. Shepard, David C. Jewitt and Jan Kleyna from photographs taken from February 5 to April 3, and this was provisionally designated S/2003 S 1. A member of the Norse group, it was named Saturn XXXI Narvi by the IAU Working Group for Solar System Nomenclature in 2005.

During the historic mission of the spacecraft Cassini to the ringed planet, the satellite hunters kept finding new moons in the vast Saturnian region using both ground-based observatories and cameras onboard Cassini.

In August 2004, soon after the spacecraft Cassini finally reached Saturn on July 1, two tiny moons orbiting between Mimas and Enceladus were discovered by Sébastien Charnóz and the Cassini Imaging Team led by Carolyn C. Porco from Cassini images taken on June 1: S/2004 S 1 and S/2004 S 2 (the latter had already been identified in a Voyager 2 photo as S/1981 S 14). They were named Saturn XXXII Methone and Saturn XXXIII Pallene in 2005. The names were approved by the 26th IAU General Assembly in Prague in 2006.

On October 24, 2004 the Cassini Imaging Team announced the discovery of another moon co-orbital moon with Dione. It was discovered in images taken on October 21 and given the temporary designation S/2004 S 5. Its provisional name, Sat-

urn XXXIV Polydeuces, introduced by the IAU Working Group for Planetary System Nomenclature in 2005, was approved by the IAU General Assembly in Prague in 2006.

On May 6, 2005 Caroly C. Porco and the Cassini Imaging Science Team announced the discovery of a satellite orbiting between the inner moons Pan and Atlas in images taken by the Cassini probe on May 1, designated S/2005 S 1 or Saturn XXXV. M. Porco suggested the name Daphnis, which was accepted in 2005 and ratified by the IAU in 2006.

Twelve new moons of Saturn were announced on May 3, 2005, nearly doubling the number of known irregular satellites and bringing the total number of moons of that planet to 46. The satellites were discovered on December 12, 2004, using the wide-field camera on the 8.2-m Subaru telescope on Mauna Kea. They were followed up in January, February and March 2005 using the combined power of Subaru and the nearby 8-m Gemini North and Keck 10-m telescopes. The orbital elements were computed by Brian Marsden. All but one (S/2004 S 11) have retrograde orbits, a hallmark of a captured satellite. The provisional designations make clear that the objects were first observed in 2004:

- S/2004 S 7, still unnamed
- S/2004 S 8, named Saturn XLII Fornjot in April 2007
- S/2004 S 9, named Saturn XL Farbauti in April 2007
- S/2004 S 10, named Saturn XXXVI Aegir in April 2007
- S/2004 S 11, named Saturn XXXVII Bebhionn in April 2007
- S/2004 S 12, still unnamed
- S/2004 S 13, still unnamed
- S/2004 S 14, named Saturn XLIII Hati in April 2007
- S/2004 S 15, named Saturn XXXVIII Bergelmir in April 2007
- S/2004 S 16, named Saturn XLI Fenrir in April 2007
- S/2004 S 17, still unnamed
- S/2004 S 18, named Saturn XXXIX Bestla in April 2007

Scott S. Sheppard, David L. Jewitt and Jan Kleyna also reported on June 9, 2006, the discovery of nine new satellites of Saturn based on data obtained during the months of December 2004 to March 2005 and January to April 2006 with the Subaru 8.2-m reflector, all of which showed retrograde orbits:

- S/2004 S 19, named Saturn XLIV Hyrokkin in April 2007 (changed to Hyrrokkin in July 2007)
- S/2006 S 1 of the Norse group, yet to be named
- S/2006 S 2, named Saturn XLV Kari in April 2007
- S/2006 S 3 of the Norse group, yet to be named
- S/2006 S 4 of the Norse group (discovered on January 5, 2006)
- S/2006 S 5, named Saturn XLVI Loge in April 2007
- S/2006 S 6 of the Norse group (discovered on January 5, 2006)
- S/2006 S 7, later named Saturn XLVIII Surtur in April 2007
- S/2006 S 8, named Saturn XLVII Skoll in April 2007

The names in these two lists are still to be approved by the next IAU General Assembly. S.S. Sheppard, D.C. Jewitt and J. Kleyna also made some discoveries in 2007:

S/2007 S 1 of the Inuit group (discovered on January 16, 2007)

S/2007 S 2 of the Norse group, yet to be named

S/2007 S 3 of the Norse group, yet to be named

The satellites S/2006 S 6, S/2006 S 4, and S/2007 S 1 were verified by Brian Marsden in September 2007 and then named Saturn L Jarnsaxa, Saturn LI Greip, and Saturn LII Tarqeq by the IAU Working Group for Planetary System Nomenclature based on proposals by the discoverers. The WGPSN on this occasion extended the theme of Inuit names for outer Saturnian satellites with orbital inclinations of around 48° to the ecliptic to Inuit spirits (not just giants).

On May 30, 2007, a dot or speck in the region between Saturn XXXII Methone and Saturn XXXIII Pallene was discovered by Carolyn Porco and other members of the Cassini Imaging Team in a series of images from Cassini's wide-angle camera. When the Cassini scientists looked back through their image database since June 2004, they were able to track the tiny dot as it orbited Saturn between the orbits of the other two satellites. Using this data set, the team was able to establish a good orbit for the new satellite which, provisionally designated S/2007 S 4 and nicknamed Frank, was then numbered Saturn XLIX. Carolyn Porco then proposed to name the confirmed satellite, like Methone and Pallene, after one of the beautiful daughters of Alkyoneos, Anthe. The name was approved by the WGPSN in August 2007. Carolyn Porco assumes that the three tiny bodies in a row are members of a band of Anthe-sized moonlets circling Saturn that have a common origin of a protosatellite that broke into pieces.

In the middle of 2007 four propeller-shaped features were also detected in Saturn's A Ring, proof for the presence of large boulder-sized moonlets in the rings. Their existence favors ring creation through a collisional cascade from an icy satellite rather than a co-genetic origin with Saturn. In 2007 (*Nature*, 449, 1019–1021), the detection of eight new propeller features in an image of the A Ring was reported, indicating embedded moonlets with radii of between 30 m and 70 m, concentrated in a narrow 3000-km wide annulus 130,000 km from Saturn.

Discovering and Naming the Rings

The first person to observe the rings of Saturn was Galileo Galilei with his 20-power telescope in 1610, who described them as “handles” or large moons on either side of the planet, and later in 1616 as two half ellipses. It was not until 1655 that Christiaan Huygens, based on observations with his 50-power refractor, was able to state (in *De Saturni Luna Observatio Nova*) that Saturn was surrounded by a solid ring: “Annolo cingitur, tenui, plano, nusquam cohaerente, ad eclipticam inclinatio.”

In 1676, Jean-Dominique Cassini (1677–1756) discovered a gap between the outer (A) and the inner (B) rings. This soon became known as the Cassini Division.

In 1825, Henry Kater (1777–1835) reported seeing three gaps in the A Ring, but none were verified until Encke’s discovery in 1837.

On 25 April 1837, Johann Encke (1791–1865) noticed a dark band—later called the Encke Division—in the middle of the A ring (William Herschel had already reported a “black list,” or linear markings on one side of the A Ring near its inner edge, in 1780).

In 1850, William Cranch Bond (1789–1859) and George Philip Bond (1825–1865) observed a dark band across Saturn immediately adjacent to the interior edge of the B Ring. This ring, which had been vaguely observed by Johann Gottfried Galle (1812–1910) in 1838, was originally known as the Crepe Ring, and later officially became known as the C Ring.

In 1856, James Maxwell deduced that the Saturn’s rings could not be solid and must be made of “an indefinite number of unconnected particles.”

In 1895, James Keeler and William Campbell observed that the inner part of the rings orbit more rapidly than the outer part of the rings, confirming Maxwell’s deduction in 1856 that Saturn’s rings were made up of small particles. In 1967, Walter Feibelman discovered the E Ring from Allegheny Observatory images taken the year before. In 1967, Pierre Guerin found evidence of a possible D Ring. In 1977, Stephen James O’Meara was the first to describe dark radial features (later called “spokes”) on Saturn’s B Ring.

On 1 September 1979, the F Ring was discovered and the E Ring was confirmed with the imaging photopolarimeter aboard the US space probe Pioneer 11. The D Ring is separated from the C Ring by the Guerin Division, named after the discoverer of the D Ring. The F Ring is separated from the A Ring by the provisionally named Pioneer Division (1979, *IAU Circular*, 3417), renamed in 2007 at the Cassini imaging team’s suggestion to the Roche Division, after the French astronomer Edouard Roche (1820–1883), who calculated the shortest and greatest possible distances between a planet and its satellite: the Roche limit. The neighboring ring R/2004 S 2 at the outer edge of the A Ring (2004, *IAU Circular*, 8432) is at the Roche limit. The F ring is a narrow, tortured ribbon that is shepherded by the moons Prometheus and Pandora (“F is for freewheeling”). A division between the B and C rings, a gap near the center of the Cassini Division, and details in the A, B and C rings have been seen, and the nomenclature of divisions and gaps was redefined (1980, *Science*, 207, 4429, 434–439).

When the Voyager 1 and Voyager 2 spacecraft, launched in 1977, flew by Saturn in November 1980 and August 1981, much information on the rings was obtained: the G ring was discovered; the “spokes” on the B ring were confirmed; and braiding was seen in the F ring. The D ring was confirmed. Three divisions in the D ring, provisionally designated D 68, D 72, and D 73, were detected.

The rings were found to consist of thousands of ringlets. Ringlets were even found in gaps in the rings; among others, two very narrow ringlets within the Cassini Division which has been nicknamed the “Charming Ringlet.”

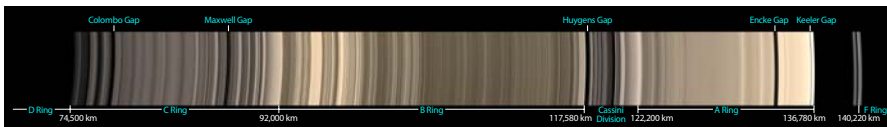
In 1982 the IAU General Assembly approved the newly defined divisions and gaps in Saturn’s rings:

- The Cassini Division, the prominent division between the A ring and the B ring (after Giovanni Cassini, 1625–1712)
- The Encke Division, the widest division in the A ring (after J.F. Encke, 1791–1865), which was renamed in January 2008 to the Encke Gap
- The Huygens Gap, the gap at the inner edge of the Cassini division (after Christiaan Huygens, 1629–1695)
- The Keeler Gap, the gap near the outer edge of the A ring (after James A. Keeler, 1857–1908)
- The Maxwell Gap, the widest gap in the C Ring (after James C. Maxwell, 1831–1879)

However, we owe much of our knowledge of the rings to the Cassini spacecraft (a joint NASA/ESA project), which arrived at Saturn in July 2004 and will orbit the planet for at least four years. It showed that the rings were made up of thousands of ringlets. As reported by the Cassini Imaging Team:

- In 2004, Cassini imaged a faint, tiny ring that was temporarily designated R/2004 S 1 (*IAU Circular*, 8401) within the orbit of Atlas and the outer edge of the A Ring R/2004 S 2 (*IAU Circular*, 8432, see above).
- In 2005, the Colombo Gap was discovered in the middle of the C ring. It contains the bright and narrow Colombo Ringlet (named after the Italian astronomer Giuseppe Colombo), also called the Titan Ringlet, as it is governed by an orbital resonance with the satellite Titan.
- In 2006, R/2006 S 2 (a faint dust ring that shares Pallene’s orbit) was observed, as were ringlets in the gaps between rings, such as R/2006 S 3 and R/2006 S 4 in the Cassini Division. One of them was nicknamed the Charming Ringlet.
- In 2007, propeller-shaped features were seen in Saturn’s A Ring (see the end of the previous section), as were details in the G Ring, which is fed by the erosion of ice particles from the inner rim of the G Ring.

The difference between divisions and gaps was defined in 2007 by the IAU Working Group for Planetary System Nomenclature as follows: divisions are the separations between named rings (they are large), and gaps are the spaces within named rings (they are small).



Natural-color mosaic of Cassini narrow-angle camera images of the unilluminated side of Saturn’s D, C, B, A and F rings. Copyright Cassini Imaging Team, SSL, JPL, ESA, NASA

Our knowledge of the Saturnian rings and their divisions and gaps in 2007 is summarized in the following table, showing the name of the ring feature, its width and its distance from the center of Saturn.

Ring feature	Width (km)	Distance from the center of Saturn (km)
D Ring	7,500	66,900
Division D	68	?
Division D	72	?
Division D	73	30
Guerin Division	1200	74,310
C[repe] Ring	17,500	74,658
Colombo Gap	100	77,800
Titan Ringlet	?	77,800
Maxwell Gap	270	87,491
B Ring	25,300	92,000
Cassini Division	4,700	117,580
R/2006 S 3, R/2006 R 4, Charming Ringlet		
Huygens Division	285–400	117,680
A Ring	14,600	122,170
Encke Gap	325	133,589
Keeler Division	35	136,530
Ring R/2004 S 1	300	137,630
Ring R/2004 S 2	?	138,900
Roche Division	2600	136,780–139,380
F Ring	30–500	140,180
Ring R/2006 S 1	?	151,450
G Ring	5,000	170,000
E Ring	302,000	181,000
“Pallene Ring R/2006” S 2	?	211,000

Other narrow rings in the main rings that currently have no names may need to be named in the near future.

The Cassini spacecraft found evidence of at least one ring orbiting Rhea, as reported by Geraint Jones and his team at the Max Planck Institute for Solar System Research, Katlenburg–Lindau, Germany, and the Mullard Space Science Laboratory, University College, London (2008, *Science*, 319, 1380–1384). This is the first time that rings have been found around a moon.

The apparent debris disk measures several thousand miles from end to end. An additional dusk cloud may extend up to 5,900 kilometers from the moon’s center—almost eight times the radius of Rhea. This was detected by a suite of six instruments on Cassini that were specifically designed to study the atmospheres of Saturn and its moons, and particles around them. The discovery was a result of Cassini performing a close flyby of Rhea in November 2005, when instruments on the spacecraft observed the environment around the moon.



Rhea's ring (artist's conception). Copyright JPL

Sources of Satellite Names

Saturn I MIMAS (Μίμωας)

A Giant, son of Tartarus and Ge (Gaia), felled by Ares in the war between the Titans and the Olympian gods.

Claudianus: Gigantomachia 85–91:

Mimas ran forward to avenge his brother [Pelorus]. He had torn Lemnos and with it Vulcan's fiery house from out the foaming main, and was on the point of hurling it when Mars' javelin prevented him, scattering the brain from his shattered skull. What was giant in him died, but the serpent legs still lived, and, hissing vengeance, sought to attack the victor after Mimas' death.



Giant

Saturn II ENCELADUS (Εγκελαδος)

“The roaring;” son of Tartarus and Ge and leader of the Giants in the war between the Titans and the Olympian gods. Crushed by Athena.

Apollodorus: Bibliotheca 1,6,2:

Enceladus fled, but Athena threw on him in his flight the island of Sicily, and she flayed Pallas and used his skin to shield her own body in the flight.

Claudianus: De Raptu Proserpinae 1,153–159:

(On Trinacria/Sicily:) In the midst of the island rise the charred cliffs of Aetna, eloquent monument of Jove’s victory over the Giants, the tomb of Enceladus, whose bound and bruised body wreathes forth endless sulphur clouds from its burning wounds. When’r his rebellious shoulders shift their burden to the right or left, the island is shaken from its foundations and the walls of tottering cities away this way and that Ge stived up her sons to war.

Saturn III TETHYS (Τηθυς)

Daughter of Uranus and Ge, wife of Oceanus and mother of rivers and Oceanids.

Hesiodus: Theogonia 337–362:

Tethys bare to Ocean eddying rivers, Nilus, and Alpheus, and deep-swirling Eridanus (...). Also she brought forth a holy company of daughters who with the lord Apollo and the Rivers have youths in their keeping (...). For there are three thousand neat-ankled daughters of Ocean [the Oceanids] who are dispersed far and wide, and in every place alike serve the earth and the deep waters ...



Okeanos and Tethys

Homerus: Ilias 14,301–306:

(Hera to Zeus:) I am faring to visit the limits of the all-nurturing Earth, and Oceanus, from whom the gods are sprung, and mother Tethys, even them that lovingly nursed and cherished me in their halls. Them I am faring to visit, and will loose for them their endless strife, since now for long time’s space they hold aloof one from the other, from the marriage-bed and from love, for that wrath hath fallen upon their hearts...

Saturn IV DIONE (Διώνη)

Sister of Kronos, mother of Aphrodite by Zeus.

Homerus: Ilias 5,370–383:

(In Olympus) fair Aphrodite flung herself upon the knees of her mother Dione. She clasped her daughter in her arms, and stroked her with her hand and spake to her, saying: “Who now of the sons of heaven, dear child, hath entreated thee thus wantonly, as though thou wert working some evil before the face of all?”

To her then made answer laughter-loving Aphrodite: “Tydeus’ son, Diomedes high of heart, wounded me, for that I was bearing forth from out the war my dear son Aeneas, who is in my eyes far the dearest of all men. For no longer is the dread battle one between Trojans and Achaeans; nay, the Danaans now fight even with the immortals.”

To her then made answer Dione, the fair goddess: “Be of good heart, my child, and endure for all suffering ... ”



Zeus and Dione

Saturn V RHEA (Ρέα)

A Titaness, daughter of Uranus and Ge. Mother of Zeus, Poseidon and Hades by Kronos.

Hesiodus: Theogonia 453–491:

Rhea was subject in love to Kronos and bare splendid children, Hestia, Demeter, and goldshod Hera and strong Hades, pitiless in heart, who dwells under the earth, and the loud-crashing Earth-Shaker [Poseidon], and wise Zeus, father of gods and men, by whose thunder the wide earth is shaken. (...) He [Kronos] learned from Earth and starry Heaven that he was destined to be overcome by his own son (...). Therefore he (...) swallowed down his children: and unceasing grief seized Rhea [until] she was about to bear Zeus. (...). Him did vast Earth receive from Rhea in wide

Crete to nourish and to bring up. (...); but to the mightily ruling son of Heaven, the earlier king of the gods, she gave a great stone wrapped in swaddling clothes. Then he took it in his hands and thrust it down into his belly: wretch! He knew not in his



Rhea and Kronos

heart that in place of the stone his son was left behind, unconquered and untroubled, and that he was soon to overcome him by force and might and drive him from his honours, himself to reign over the deathless gods.

Saturn VI TITAN (ΤΙΤΑΝ)

One of the older gods who existed before the Olympians (children of Uranus and Ge).

Diodorus Siculus 5,66,2:

The Titans numbered six men and five women, being born, as certain writers of myths relate, of Uranus and Ge, but according to others, of one of the Curetes and Titaea, from whom as their mother they derive the name they have.

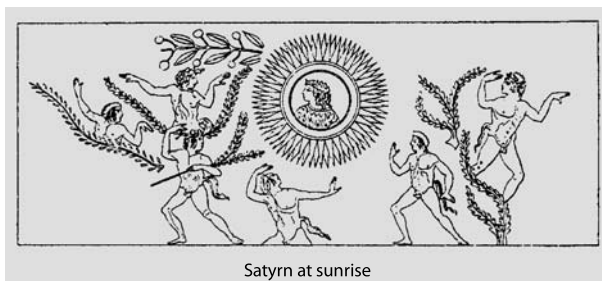
Hesiodus: Theogonia 207–210; 710–731:

But these sons whom he begot himself great Heaven used to call Titans (Strainers) in reproach, for he said that they strained and did presumptuously a fearful deed, and that vengeance for it would come afterwards.

An horrible uproar of terrible strife arose [between the Olympians and Kronos and also the other Titans]: mighty deeds were shown and the battle inclined. But until then, they kept at one another and fought continually in cruel war. And amongst the foremost Kottos and Briareos and Gyes [eldest sons of Ge] insatiate for war raised fierce fighting: three hundred rocks, one upon another, they launched from their strong hands and overshadowed the Titans with their missiles, and hurled them beneath the wide-pathed earth, and bound them in bitter chains when they had conquered them by their strength for all their great spirit, as far beneath the earth as heaven is above earth; for so far is it from earth to Tartarus. (...) There by the counsel of Zeus who drives the clouds the Titan gods are hidden under misty gloom, in a dank place where are the ends of the huge earth.



Titan



Satyrn at sunrise

Saturn VII HYPERION (ΥΠΕΡΙΩΝ)

A Titan, son of Uranus and Ge; father of Helios, Selene and Eos.

Hesiodus: Theogonia 371–374:

And Theia was subject in love to [her brother] Hyperion and bare great Helios (Sun) and clear Selene (Moon) and Eos (Dawn) who shines upon all that are on earth and upon the deathless Gods who live in the wide heaven.

Diodorus Siculus 5,66,5–67,1:

Each of [the Titans] was the discoverer of things of benefit to mankind, and because of the benefaction they conferred upon all men they were accorded honours and everlasting fame (...) Of Hyperion we are told that he was the first to understand, by diligent attention and observation, the movement of both the sun and the moon and the other stars, and the seasons as well, in that they are caused by these bodies, and to make these facts known to others; and that for this reason he was called the father of these bodies, since he had begotten, so to speak, the speculation about them and their nature.

Saturn VIII JAPETUS (ΙΑΠΕΤΟΣ)

A Titan, son of Uranus and Ge; father by Clymene the Oceanid of Atlas, Menoetius, Prometheus, and Epimetheus.

Hesiodus: Theogonia 132–136; 507–512:

(Earth) lay with Heaven and bare deep-swirling Oceanus, Coeus and Crius and Hyperion and Iapetus. (...) Now Iapetus took to wife the neat-ankled maid Clymene, daughter of Ocean, and went up with her into one bed. And she bare him a stout-hearted son, Atlas: also she bare very glorious Menoetius and clever Prometheus (and) Epimetheus.

Silius Italicus: Punica 12,147–151:

(Hannibal and his guides) could see Prochyle, the place appointed for savage Mimas, and Inarime in the distance, which stands above Iapetos, while he spouts forth black smoke and flame from his mutinous jaws, and seeks, if he is ever suffered to get free, to renew his war against Jupiter and the gods.



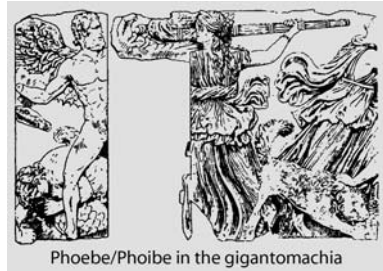
Japetus

Saturn IX PHOEBE (Φοιβη)

A Titaness, daughter of Uranus and Ge; wife of Coeus and mother of Leto.

Hesiodus: Theogonia 404–413:

Phoebe came to the desired embrace of Coeus. Then the goddess through the love of the god conceived and brought forth dark-gowned Leto, always mild, kind to men and to the deathless gods, mild from the beginning, gentlest in all Olympus. Also she bare Asteria of happy name, whom Perses once led to his great house to be called his dear wife. And she conceived and bare Hecate whom Zeus the son of Cronos honoured above all.



Aeschylus: Eumenides:

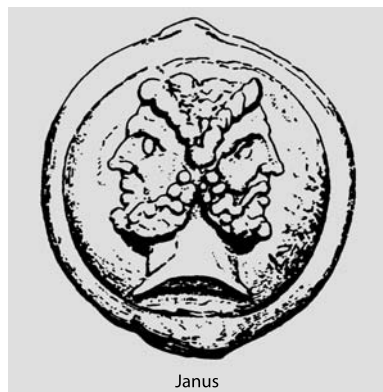
(The Pythian prophetess in Apollo's shrine at Delphi:) I give pride of place in this prayer first to all the gods to Earth, primeval prophetess, and after her to Themis, for she was second to sit in this, her mother's shrine of prophecy (so the story goes). In third assignment—the change was voluntary; no one exerted pressure—another Titaness, daughter of Earth, took up the seat, Phoebe by name, who then gave it as a birthday-gift to Phoebus, who thus has Phoebe's name besides his own.

Saturn X JANUS

The double-headed Roman god of the beginning, and equivalent to the sky.

Ovidius: Fasti 1,89–112:

But what god am I to say thou art, Janus of double shape? For Greece hath no divinity like thee. The reason, too, unfold why alone of all the heavenly ones thou dost see both back and front. While thus I mused, the tablets in my hand, methought the house grew brighter than it was before. Then of a sudden sacred Janus, in his two-headed shape, offered his double visage to my wondering eyes. A terror seized me, I felt my hair stiffen with fear, and with a sudden chill my bosom froze. He, holding in his right hand his staff and in his left the key, to me these accents uttered from his front mouth: "Dismiss thy fear, thy answer take, laborious singer of these days, and mark my words. The ancients called me Chaos, for a being from of old am I; observe the



long, long ages of which my song shall tell. Yon lucid air and the three other bodies, fire, water, earth, were huddled all in one. When once through the discord of its elements, the mass parted, dissolved, and went in diverse ways to seek new homes, flame sought the height, air filled the nearer space, while earth and sea sank in the middle deep. 'Twas then that I, till that time a mere ball, a shapeless lump, assumed the face and members of a god.

Saturn XI EPIMETHEUS (Επιμηθευς)

“The afterthought,” son of the Titan Iapetus. He received his wife Pandora as a gift from Zeus and afterwards learned that she brought disaster to mankind.

Hesiodus: Opera et Dies 83–97:

When he had finished the sheer, hopeless snare [the human wife Pandora, see Saturn XVII Pandora], the Father sent glorious Argus-Slayer, the swift messenger of the gods [Hermes], to take it to Epimetheus as a gift. And Epimetheus did not think on what Prometheus had said to him, bidding him never take a gift of Olympian Zeus, but to send it back for fear it might prove to be something harmful to men. But he took the gift, and afterwards, when the evil thing was already his, he understood.

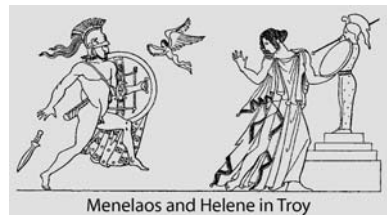
For ere this the tribes of men lived on earth remote and free from ills and hard toil and heavy thicknesses which bring the Fates upon men; for in misery men grow old quickly. But the woman took off the great lid of the jar [containing the gifts of the gods for Pandora] with her hands and scattered all these and her thought caused sorrow and mischief to men. Only Hope remained there in an unbreakable home within under the rim of the great jar, and did not fly out at the door.

Saturn XII HELENE (Ελενη)

A pre-Hellenic goddess; according to Homer she was the human spouse of Menelaus. Her abduction by Paris caused the Trojan War.

Euripides: Helene 17–38:

(Helen:) My sire was Tyndarus. The tale
Telleth that to my mother Leda flew
Zeus who had stolen the likeness of a swan,
And, fleeing from a chasing eagle, wrought
By guile his pleasure, —if the tale be true.
Helen my name, and these my sufferings:
In strife for beauty came three goddesses
To Paris in a deep Idaean dell—
Hera, and Cypris, and Zeus' child, the Maid,
Fain to bring beauty's judgment unto issue.
And Cypris tempting Paris—he should wed



Menelaos and Helene in Troy

My fairness, if misfortune can be fair, —
 Prevailed: Idaean Paris left the herds,
 And for his bride, for me, to Sparta came.
 But Hera, wroth that she should not prevail,
 Turned into air Alexander's joy of me;
 Gave him not me, but fashioned like to me
 A breathing phantom, out of cloudland wrought,
 For Priam's princely son [Menelaus]: he deemed me his,
 Who was not, a vain phantasy. Withal
 Zeus' counsels to these evils added more;
 For war he brought upon Hellenes' land ...

Saturn XIII TELESTO (Τελεστω)

A daughter of the Titan Oceanus and Tethys.

Hesiodus: Theogonia 346–379:

Also she [Tethys] brought forth a holy company of daughters who with the lord Apollo and the Rivers have youths in their keeping (...) Telesto saffron-clad, Chryseis and Asia and charming Calypso ...

Saturn XIV CALYPSO (Καλυψω)

A nymph. Daughter of Atlas who lived on the island of Ogygia, at the "sea's navel."

Homerus: Odyssea 7,250–263:

(Odysseus to Arete:) Zeus had smitten my swift ship with his bright thunderbolt, and had all clasped in my arms the keel of my curved ship and was borne drifting for nine days, and on the tenth black night the gods brought me to the isle, Ogygia, where the fair-tressed Calypso dwells, a dread goddess. She took me to her home with kindly welcome, and gave me food, and said that she would make me immortal and ageless all my days; but she could never persuade the heart in my breast. There for seven years' space I remained continually, and ever with my tears would I wet the immortal raiment which Calypso gave me. But when the eighth year came in circling course, then she roused me and bade me go, either because of some message from Zeus, or because her own mind was turned.



Hermes and Kalypso

Saturn XV ATLAS (Ατλας)

A Titan, son of Iapetos and Clymene. He was the guardian of the pillars of heaven, but he later held the sky up himself.

Apollodorus: Bibliotheca 2,5,11:

Prometheus had told Hercules not to go himself after the apples [which he had to carry as eleventh labour to Eurystheus] but to send Atlas, first relieving him of the burden of the sphere; so when he was come to Atlas in the land of the Hyperboreans, he took the advice and relieved Atlas. But when Atlas had received three apples from the Hesperides, he came to Hercules, and not wishing to support the sphere he said that he wanted to put a pad on his head. When Atlas heard that, he laid the apples down on the ground and took the sphere from Hercules. And so Hercules picked up the apples and departed.

**Saturn XVI PROMETHEUS** (Προμηθευς)

“The forethought;” son of the Titan Iapetos and Clymene the Oceanid. Creator of man who received the gift of fire from him (and he gave man fire again after Zeus had hidden it away).

Apollodorus: Bibliotheca 1,7.1–2:

Prometheus moulded men out of water and earth and gave them also fire, which, unknown to Zeus, he had hidden in a stalk of fennel. But when Zeus learned of it, he ordered Hephaestus to nail his body to Mount Caucasus, which is a Scythian mountain. On it Prometheus was nailed and kept bound for many years. Every day an eagle swooped on him and devoured the lobes of his liver, which grew by night. That was the penalty that Prometheus paid for the theft of fire until Hercules afterwards released him (...) And Prometheus had a son Deucalion. He reigning in the regions about Phthia, married Pyrrha, the daughter of Epimetheus and Pandora, the first woman fashioned by the gods. And when Zeus would destroy the men of the Bronze Age, Deucalion by the advice of Prometheus constructed a chest [to be saved].



Saturn XVII PANDORA (Πανδώρα)

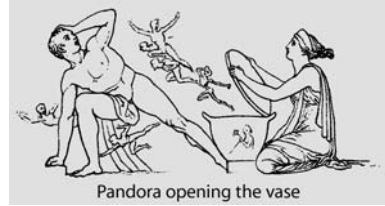
The first woman, formed by Hephaestus at the request of Zeus (then the spouse of Epimetheus).

Hesiodus: Opera et Dies 58–82:

(Zeus to Prometheus:) “I will give men as the price for fire an evil thing in which they may all be glad of heart while they embrace their own destruction.”

So said the father of men and gods, and laughed aloud. And he bade famous Hephaestus make haste and mix earth with water and to put in it the voice and strength of human kind and fashion a sweet, lovely maiden-shape, like to the immortal goddesses in face; and Athene to teach her needlework and the weaving of the varied web; and golden Aphrodite to shed grace upon her head and cruel longing and cares that weary the limbs. And he charged Hermes (...) to put in her a shameless mind and a deceitful nature.

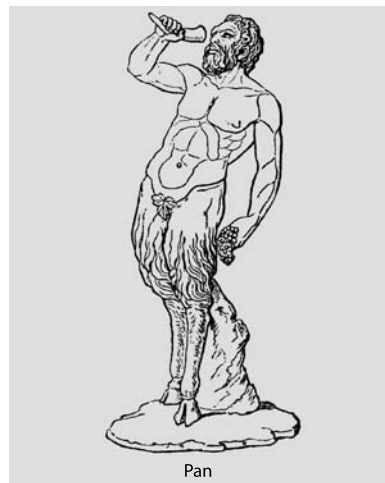
So he ordered. And they obeyed the lord Zeus the son of Kronos. (...) And he called this woman Pandora [“the all-endowed”], because all they who dwelt on Olympus gave each a gift, a plague to men who eat bread.

**Saturn XVIII PAN** (Παν)

God of shepherds, son of Hermes and a nymph, he was half goat and half human.

Homeri Hymnus ad Panem 1–17:

Muse, tell me about Pan, the dear son of Hermes, with his goat's feet and two horns—a lover of merry noise. Through wooded glades he wanders with dancing nymphs who foot it on some sheer cliff's edge, calling upon Pan, the shepherd-god, long-haired, unkempt. He has every snowy crest and the mountain peaks and rocky crests for his domain; hither and thither he goes through the close thickets, now lured by soft streams, and now he presses on amongst towering crags and climbs up to the highest peak that overlooks the flocks. Often he courses through the glistening high mountains, and often on the shouldered hills he speeds along slaying wild beasts, this keen-eyed god. Only at evening, as he returns from the chase, he sounds his note, playing sweet and low on his pipes of reed.



Saturn XIX YMIR

“The roaring;” progenitor of the race of frost giants. A primordial Norse giant, he was killed by the Aesir/Ases in order to create the world.

Saemundar Edda: Voluspá 3:

In time’s morning lived Ymir,
Then was no sand, sea, nor cool waves;
No earth was there, nor Heaven above,
Only a yawning chasm, nor grass anywhere.

Snorra Edda: Gylfaginning 7–8:

The sons of Bor [Odin, Vili, and Ve] slew the giant Ymir, and when he fell there ran so much blood from his wounds that the whole race of Frost-giants was drowned in it, except a single giant, who saved himself with his household. He is called by the giants Bergelmir. He escaped by going on board his bark, and with him went his wife, and from them are descended the Frost-giants.

They (the sons of Bor) dragged the body of Ymir into the middle of Ginnungagap, and of it formed the earth. From Ymir’s blood they made the seas and waters; from his flesh the land; from his bones the mountains; and his teeth and jaws, together with some bits of broken bones, served them to make the stones and pebbles. (...) From his skull they formed the heavens, which they placed over the earth ...

Snorra Edda: Gylfaginning 56:

Thor, on one hand, darting looks of ire on the [Midgard] serpent, whilst the monster, his head, spouted out floods of venom upon him. It is said that when the giant [H]ymir beheld the serpent, he turned pale and trembled with fright and seeing, moreover, that the water was entering his boat on all sides, he took out his knife, just as Thor raised his mallet aloft, and cut the line, on which the serpent sunk again under the water. Thor, however, launched his mallet at him, and there are some who say that it struck off the monster’s head at the bottom of the sea, but one may assert with more certainty that he still lives and lies in the ocean. Thor then struck Hymir such a blow with his fist, nigh the ear, that the giant fell headlong into the water, and Thor, wading with rapid strides, soon came to the land again.



Snorra

Saturn XX PAALIAQ

A fictional shaman in the Inuit tale The Curse of the Shaman by Michael Arvaarluk Kusugak and Vladyana Langer Krykorka.

Kusugak M, Krykorka V (2006) *The Curse of the Shaman*. Harper Trophy, Toronto:

The story of two families on Marble Island, near Nunavut. After young Wolverine is born, his family travels to visit Paaliaq and his young wife and baby daughter, Breath, Qabluittuq, Wolverine's father, teases Paaliaq when his daughter would not stop crying. Paaliaq, a shaman, was feeling cranky and put a curse on Wolverine. Everyone forgot about the curse until Wolverine and Breath were all grown up. Then began the young man's struggle to overcome the mis-fired malediction ...

Saturn XXI TARVOS

A divine bull worshipped by the Celts in Gaul.

Green MJ (1992) *Dictionary of Celtic Myth and Legend*. Thames and Hudson, London, pp. 207–208:

Two stone sculptures, from Paris and Trier [Trèves] respectively, portray an image of a bull associated with three wading or marsh birds with long legs and long beaks—cranes or egrets. The Paris stone is part of the monument erected to Jupiter and dedicated by a guild of Parisian sailors during the reign of Tiberius. Here two panels of the monument are relevant: on one a god in the form of a woodcutter, named Esus ('Lord') hacks at the branch of a willow tree with an axe or chopper; on another a bull is depicted with two cranes perched on his back and a third between his horns. The inscription above the image is *Tarvos trigaranus* ('the bull with three cranes').



The stone from Trier displays imagery which is virtually identical: it was dedicated to Mercury in the first century AD by a Mediomatrician tribesman called Indus, who was perhaps a shipper on the Rhine. On one surface of the stone is a representation of Mercury and Rosmerta [a Celtic goddess of fertility and abundance], while on another a woodcutter chops at a willow in which are the head of a bull accompanied by three marsh birds. Although Esus and Tarvos are not mentioned on the Treveran stone, the repeated symbolism of woodcutter, willow, cranes and bull must identify this imagery with that of the Paris monument.

The iconography of these sculptures is interesting and enigmatic: if the birds are egrets, then their link both with bulls and willow trees is appropriate; these birds are fond of willows (both egrets and willows have an affinity with water). Egrets also enjoy a symbolic relationship with cattle (removing parasites from their hides). The other elements in this imagery are triplism and the destruction of the tree by the woodcutter. The association of water, tree and birds may imply the presence of cyclical imagery: the tree of life may be depicted, the birds representing spirits which are released when the tree is chopped down; but trees are reborn after the 'death' of winter, and this seasonal myth may be enacted on these monuments. The bull reflects potency, sexual vigour and strength, which would enhance the fertility symbolism of the tree.

Saturn XXII IJIRAQ

A fictional Innuite who looked like a boy with scaly clothes and long fingers, as described by the children's book author Michael Kusugak.

Kusugak MA (1994) *Hide and Sneak*.

Annick, Toronto:

There was once an Ijirak who, like all other Ijiraks, loved to play hide-and-seek. But most of all he liked to help little kids hide, and when he hid little kids, they were never found again. That, of course, is what Ijiraqs do: they help you hide, and when they help you hide, no one ever finds you again.

But our Ijirak was a little different from other Ijiraqs: he was always getting lost. Whenever he went out to hide kids, he could not find his way home. And his friends teased him: Funny little Irijaq / Getting lost among the rocks / Naa-na-na-naa ...



Saturn XXIII SUTTUNGR

A Norse giant who kindled flames that destroyed the world.

Snorra Edda: *Bragarödur 3/Gylfaginning 71:*

(The dwarfs) Fjalar and Galar managed to drown the giant Gilling and murder his wife, deeds which were avenged by their son Suttungr taking the dwarfs out to sea, and placing them on a shoal which was flooded at high water. In this critical position they implored Suttungr to spare their lives, and accept the verse-inspiring beverage

[a mixture of Kvasir's blood and honey] which they possessed as an atonement for their having killed his parents. Suttungr having agreed to these conditions, released the dwarfs, and carrying the mead home with him, committed it to the care of his daughter Gunnlauth. Hence poetry is indifferently called Kvasir's Blood, Suttungr's mead [and the beverage of the gods (after Odin obtained possession of so valuable a beverage)].

Saemundar Edda: Havamal 110–111:

On the following day came the Hrim-thusar [frost-giants], to hear Odin's counsel in the High Hall; after Bolverk they inquired, whether he with the gods were come, or Suttungr had destroyed him? Odin, I believe, a ring-oath gave. Who in his faith will trust? Suttungr defrauded, of his drink bereft, and Gunlod made to weep!

Saturn XXIV KIVIUQ

A hero of epic stories of the Inuit.

Wikipedia (<http://en.wikipedia.org/wiki/Kiviuq>):

Kiviuq is an eternal Inuit wanderer. He walks, or travels by dog sled, kayak, or may be borne by huge fishes. His supernatural powers allow him to overcome all manners of obstacles in his travels. He has had many lives. Inuit elders say that he is in his last life now, on an adventure somewhere. Oral tradition has preserved many versions of the Kiviuq story-cycle.



Kivioq

Rink H (1885) Tales and Traditions of the Eskimo. London, p. 238:

Kivioq (...) ran back to his kayak. He had hardly set out when an eagle swept down and tried to carry him off. He escaped only by smashing the eagle's head with his paddle. Then the ghosts of drowned people rose up from the water and sat on his kayak for they hoped to drown him as they themselves had been drowned. Yet Kivioq paddled on, despite so much extra weight.

Now he was joined by the ghosts of his wife and her lover. The drowned people complained that there wasn't enough room for all of them on the kayak, but the wife and her lover found a place anyway.

"It was very unkind of you to kill me", she said to Kivioq.

"But you were already dead ..."

"To kill a person who is already dead", she said, "that is the unkindest thing of all."

Years seemed to pass with all these ghosts on the back of the kayak. He seemed to paddle everywhere, up and down every fjord, everywhere in the entire country. Each year the kayak got heavier and heavier, but he paddled on.

Saturn XXV MUNDILFARI

A Norse giant, father of Sol (sun) and Bil (moon).

Snorra Edda: Gylfaginning 11:

There was formerly a man (...) named Mundilfari, who had two children so lovely and graceful that he called the male, Mani (moon), and the female, Sol (sun), who espoused the man named Glenur. But the gods being incensed at Mundilfari's presumption, took his children and placed them in the heavens, and let Sol drive the horses that draw the car of the sun (...) Mani was set to guide the moon in his course.

Saturn XXVI ALBIORIX

A Gallic deity equivalent to Mars, or an epithet meaning "king of the world".

Green MJ (1992) Dictionary of Celtic Myth and Legend. Thames and Hudson, London, p. 141:

Albiorix was venerated as a tribal guardian in southern Gaul. He was the topographical mountain spirit of the little tribe of the Albici in Vaucluse. Whilst the god's name and the tribe appear to have thus close etymological association, some scholars have interpreted the name Albiorix as meaning "king of the world".

Saturn XXVII SKATHI

Skadi/Skaði, a Norse giantess, daughter of the giant Thjassi, and wife of Njord.

Snorra Edda: Gylfaginning 70:

Thjassi (...) fell into the power of the Aesir, who slew him within the portals of the celestial residence. When these tidings came to Thjassi's daughter Skadi, she put on her armour and went to Asgard, fully determined to avenge her father's death; but the Aesir having declared their willingness to atone for the deed, an amicable arrangement was entered into. Skadi was to choose a husband in Asgard, and the Aesir were to make her laugh. Her choice of a husband was to be determined by a mere inspection of the feet of the gods, it being stipulated that the feet should be the only part of their persons visible until she had made known her determination. In inspecting the row of feet placed before her, Skadi took a fancy to a pair which she flattered herself, from their fine proportions, must be those of Bald(u)r. They were however Njord's, and Njord was accordingly given her for a husband, and as Loki managed to make her laugh by playing some diverting antics with a goat, the atonement was fully effected.

Snorra Edda: Gylfaginning 24:

Njord, who dwells in the heavenly region called Noatum, rules over the winds, and checks the fury of the sea and of fire, and is therefore invoked by sea-farers and fishermen. He is so wealthy that he can give possessions and treasures to those who call on him for them. (...) Njord took to wife Skadi, the daughter of the giant Thjassi. She preferred dwelling in the abode formerly belonging to her father, which is situated among rocky mountains, in the region called Thrymheim, but Njord loved to reside near the sea. They at last agreed that they should pass together nine nights in Thrymheim, and then three in Noatum ...

Saturn XXVIII ERRIAPUS

A Gallic deity, equivalent to Mercury.

Revue de Comminges et des Pyrénées centrales. Saint-Gaudens, vol. 59 (1946), pp. 293–300 (Latin votive inscriptions of Aquitania to Erriapus, also quoted in L'Année Épigraphique, Paris, année 1949, nos. 113–126. No. 126):

Erriapo Deo Gomferani posuerunt v(otum) s(olvent) l(ibens) m(erito). (transl.: To the god Erriapus [dative: Erriapo] the Gomferani [inhabitants of the village Géry in Saint-Béat] paid their vow willingly and deservedly.)

MacKillop J (1998) Dictionary of Celtic Mythology. OUP, Oxford, p. 170:

Erriapus: name given to a local god in southern Gaul, probably the equivalent of The Gaulish Mercury; another name for Mercury may have been Lugos. A portrayal of his head, seen emerging from foliage, was found in the Garonne region of southern France.

Duval P-M (1957) Les Dieux de la Gaule. Payot, Paris, p. 80:

Near the quarries of Saint-Béat (Haute-Garonne) the number of altars offered to the local god Erriapus pushes into the background those of Silvain/Silvanus, but on those of the latter the Roman forest god is depicted as aged, thickset, moustachioed or bearded, clothed with a short-sleeved double tunica and holding in one hand a goat and in the other a jug or a purse. This is not at all the appearance of the classic Silvain: a further step of adaption, and we would have in these wooded mountains of the Pyrenees a Silvanus Erriapus. The shape here lent to Silvain is otherwise that of Mercury or Sucellus [the god with the woodhammer], is that of the ordinary Gaul.

Saturn XXIX SIARNAQ

An Innuite goddess of the sea and queen of the Eskimo underworld, better known as Sedna (already the name of a Trans-Neptunian Object).

***Native American Mythology* (<http://www.godchecker.com>):**

Sedna, also known as (...) Siarnaq, is a sinister hag with one eye, no fingers, and a giant bloated body. She is sometimes depicted as a walrus. This is a far cry from the good old days when she was a beautiful maiden. That's what being sacrificed to the sea does to you. (...) She rules all Arctic Sea life, deciding the fate of all ocean creatures—and the people who hunt them. If you haven't said a prayer to Sedna, you may as well pack up your harpoon and go home. But if you can adopt a shamanic trance, descend into the depths and comb her dark tresses, she'll send you a seal or maybe a walrus or two for dinner.

As Queen of the Dead, Sedna rules over the Adivun Underworld from her eternally ice palace on the outer reaches of deathville.

Saturn XXX THRYMR

A Norse giant, god of the thunderstorm; he stole Thor's hammer.

Saemundar Edda: Thrymsvidha 9–32:

(Thrymr to Loki:) I have Hlorrid's [Thor's] hammer hidden eight rasts beneath the earth; it shall no man get again, unless he bring me Freyia to wife." (...)

Wroth then was Freyia, and with anger chafed, all the Aesir's hall beneath her trembled: in shivers flew the famed Brisinga necklace. (To the messenger she said:) "Know me to be of women lewdest, if with thee I drive to Jotunheim."

Straightway went the Aesir all to council, and the Asyniur all to converse; and deliberated the mighty gods, how they Hlorridi's hammer might get back.

Then said Heimdall, of Aesir brightest—he well foresaw, like other Vanir—"Let us clothe Thor with bridal raiment, let him have the famed Brisinga necklace. (So they did, and the alleged Freyia came to Jotunheim.)

In came the Jotun's luckless sister, for a bride-gift she dared to ask: "Give me from thy hands the ruddy rings, if thou wouldst gain my love, my love and favour all."

Then said Thrymr, the Thursar's lord: "Bring the hammer in, the bride to consecrate; lay Miollnir on the maiden's knee; unite us each with other by the hand of Vor."

Laughed Hlorrid's soul in his breast, when the fierce-hearted his hammer recognized. He first slew Thrymr, the Thursar's lord, and the Jotun's race all crashed. He slew the Jotun's eldest sister, her who a bride-gift had demanded; she a blow got instead of skillings, a hammer's stroke for many rings. So came Odin's son [Thor] by his hammer again.

Saturn XXXI NARVI

Njorvi/Narfi, a Norse giant, son of Loki and Sigyn.

Saemundar Edda: Aegisrecka/Lokasenna 65:

Loki, in the likeness of a salmon, cast himself into the waterfall of Franagr, where the Aesir caught him, and bound him with the entrails of his son Nari; but his other son, Narfi, was changed into a wolf.

Snorra Edda: Gylfaginning 10:

A giant called Njorvi, who dwelt in Jotunheim, had a daughter called Night (Nott) who, like all her race, was of dark and swarthy complexion. She was first wedded to a man called Naglfari, and had by him a son named Aud, and afterwards to another man called Annar, by whom she had a daughter called Earth (Jord). She then espoused Delling, of the Aesir race, and their son was Day, (Dagr) a child light and beauteous like his father.

Saturn XXXII METHONE (Μεθωνη)

One of the Alcyonides, daughters of the Giant Alkyoneos.

Suidas: Lexicon Graece et Latine:

Alkyonides: Their number is controversial among authors. Simonides gives eleven, Aristoteles eleven, Demagoras seven, Philochorus nine. Hegesander tells their story in his *Commentaries*. They, the daughters of the Giant Alkyoneus, named Phosthonia, Anthe, Methone, Alkipa, Pallene, Drimo, Asteria, plunged after the death of their father from Kanastraion, the foothills of Pallene, into the sea and were transformed by Amphitrite into ice birds. Since that bright and calm day they were called Alcyonii.

Saturn XXXIII PALLENE (Παλληνη)

One of the seven Alcyonides, daughters of the Giant Alkyoneos.

Nonnus: Dionysiaca 48,90–105; 183– 188:

Pallene's deathdealing father [Sithon] once had an unlawful passion for his daughter; he used to thwart her marriage and hinder every match. Wooers innumerable who would have wed her he killed, a great harvest of them; the places of wrestling were noisy with their murders and red with their blood, until Bacchos came as the champion of Justice. There was Pallene, ever so near to wedlock, and her father full of unholy passion: Bacchos came near, and proposed to make the wicked match with his horrible daughter, offering all manner of gifts. To his request of Lyaios [Bacchos] the dreadful man declared how wrestling must win the bride (...) But when Bacchos had ended the wrestling-match for his bride, still dripping with the sweat of his wedding contest he struck down Sithon with a stab of his sharp thyrsus, Sithon the murderer of wooers; and as the father rolled in the dust he gave his daughter the thyrsus that slew him, as a love-gift. That was a wedding of many songs ...

Saturn XXXIV POLYDEUCES (Πολυδευκης)

Another name for Pollux, one of the Dioscuri, sons of Zeus. The Dioscuri twins were allowed to spend alternate days alive and dead; both were later set among the stars.

Homeri Hymnus ad Dioscuros:

Bright-eyed Muses, tell of the Tyndaridae, the sons of Zeus, glorious children of neat-ankled Leda, Castor the tamer of horses, and blameless Polydeuces. When Leda had lain with the dark-clouded son of Cronos, she bare them beneath the peak of the great hill Taygetus, children who are deliverers of men on earth and of swift-going ships when stormy gales rage over the ruthless sea. Then the shipmen call upon the sons of great Zeus with vows of white lambs, going to the forepart of the prow; but the strong wind and the waves of the sea lay the ship under water, until suddenly these two are seen darting through the air on tawny wings. (...) And when the shipmen see them they are glad and have rest from their pain and labour.

Plutarchus: De Amore Fratrorum 484 E:

(Talking with Zeus) Polydeuces refused to become even a god by himself, but chose rather to become a demigod with his brother and to share his mortal portion upon the condition of yielding to Castor part of his own immortality.

Saturn XXXV DAPHNIS (Δαφνις)

A shepherd; son of Hermes, brother of Pan, descendant of Titan.

Diodorus Siculus 4,84,2:

Daphnis, a son of Hermes and a nymph (...), and since he possessed very many herds of cattle and gave great attention to their care, he was for this reason called by the name Bucolus or “Neatherd”. And being endowed with an unusual gift of song, he invented the bucolic or pastoral poem and the bucolic song which continues to be so popular throughout Sicily to the present day. The myths add that Daphnis accompanied Artemis in her hunting, serving the goddess in an acceptable manner, and that with his shepherd’s pipe and singing of pastoral songs he pleased her exceedingly. The story is also told that one of the nymphs became enamoured of him and prophesied to him that if he lay with any other woman he would be deprived of his sight; and indeed, when once he had been made drunken by a daughter of a king and had lain with her, he was deprived of his sight ...

Saturn XXXVI AEGIR

Norse ocean giant who represents the tranquil sea and pacifies storms; husband of Ran.

Snorra Edda: Skáldskaparmál 1/Gylfaginning 68:

A certain man named Aegir or Hlér dwelt on the island which is now called Hlér’s Isle [Læssø] and was well skilled in magic. He once took his way to Asgard, where he met with a very good reception. Supper time being come, the twelve mighty Aesir—Odin, Thor, Njord, Frey, Tyr, Heimdall, Bragi, Vidar, Vali, Ullur, Hœnir and Forseti, together with the Asynjor—Frigga, Freyja, Gefjon, Iduna, Gerda, Siguna, Fulla and

Nanna, seated themselves on their lofty doorn seats, in a hall around which were ranged swords of such surpassing brilliancy tat no other light was requisite. While they were emptying their capacious drinking horns, Aegir, who sat next to Bragi, requested him to relate something concerning the Aesir.

Saturn XXXVII BEBHIONN

A Celtic giantess.

Gray LH (ed)(1964) *The Mythology of All Races, vol. 3. Cooper Square, New York, p. 117:*

(The Irish hero) Fionn and his men were hunting when there met them a huge and beautiful women, whose finger-rings were as thick as three ox-goats. She was Bebhionn from Maidens' Land in the west, where all the inhabitants were women save their father (its king) and his three sons; and for the third time she had escaped from her husband, son of the King of the adjacent Isle of Men, and had come to seek Fionn's protection. As she sat by him (...), her huge husband came, and slaying her, eluded the heroes' pursuit, vanishing overseas in a boat with two rowers.

Saturn XXXVIII BERGELMIR

The father of the race of Frost-giants in Norse mythology.

Snorra Edda: *Gylfagynning 7:*

The sons of Bor [Odin, Vili, and Ve] slew the giant Ymir, and when he fell there ran so much blood from his wounds, that the whole race of Frost-giants was drowned in it, except a single giant, who saved himself with his household. He is called by the giants Bergelmir. He escaped by going on board this bark, and with him went his wife, and from them are descended the Frost-giants.

Saturn XXXIX BESTLA

Norse primeval goddess, mother of deities, daughter of the giant Bolthorn, Odin's mother.

Snorra Edda: *Gylfaginning 6:*

Immediately after the gelid vapours had been resolved into drops, there was formed out of them the cow named Audhumla. Four streams of milk ran from her teats, and thus fed she Ymir. The cow supported herself by licking the stones that were covered with salt and hoar frost. The first day that she licked these stones there sprang, towards evening, the hairs of a man, the second day a head, and on the third an entire man,

who was endowed with beauty, agility and power. He was called Bur, and was the father of Bor, who took for his wife Bestla, the daughter of the giant Bolthorn. And they had three sons, Odin, Vili and Ve; and it is our belief that this Odin is the most mighty of all the gods.

Saturn XL FARBAUTI

Norse storm giant: "the dangerous striker;" father of Loki.

Snorra Edda: Gylfaginning 34:

There is a deity, reckoned in the number of the Aesir, whom some call the calumniator of the gods, the contriver of all fraud and mischief, and the disgrace of gods and men. His name is Loki or Loptur. He is the son of the giant Farbauti. His mother is Laufey or Nal; his brothers are Byleist and Helblindi. Loki is handsome and well made, but of a very fickle mood, and most evil disposition. (...) Loki has likewise had three children by Angurboda, a giantess of Jotunheim. The first is the wolf Fenrir ...

Saturn XLI FENRIR

A monstrous wolf in Norse mythology; son of Loki and the giantess Angurboda; father of Hati and Skoll.

Snorra Edda: Gylfaginning 64:

The wolf Fenrir advancing, opens his enormous mouth; the lower jaw reaches to the earth, and the upper one to heaven, and would in fact reach still farther were there space to admit of it. Fire flashes from his eyes and nostrils. The Midgard serpent, placing himself by the side of the wolf, vomits forth floods of poison which overwhelm the air and the waters. Amidst this devastation heaven is cleft in twain, and the sons of Muspell ride through the breach. Surt(u)r rides first, and both before and behind him flames burning fire. His sword outshines the sun itself. Bifrost, as they ride over it, breaks to pieces. Then they direct their course to the battlefield called Vigrid. Thither also repair the wolf Fenrir and the Midgard serpent, and also Loki, with all the followers of Hel, and Hrym with all the Hrimthursar. But the sons of Muspell keep their effulgent bands apart on the field of battle, which is one hundred miles long on every side.

Edda: Lokasenna 38–39:

Loki said: Hold your tongue, Tyr,
 You never had the talent
 for setting two factions fairly.
 That right hand
 I will recall
 that Fenrir tore from you!

Tyr said: A hand I am deprived of,
and you of Hróðrsvitnir:
the harm is heartache for both.
And the wolf [Fenrir] too is not pleased
when he must wait in tight straits
for the day of the gods to darken.

Saturn XLII FORNJOT

Fornjót, “the old giant,” progenitor of the giants (the first dwellers in Norway). He was father of Kari, the wind; Aegir, the sea; and Logi, the fire. An early Norse storm giant.

Rafu CC (ed)(1929) Fornaldar sögur Norðrlanda. Copenhagen: Fra Fornjóti ok hans ættmönnum: Hversu Noregr Byggðist, Chap. 1:

Fornjotr had three sons, the first was Hlér [his other name is Ægir], the second Logi, the third Kári; this one commanded the wind, Logi the fire, Hlér the sea. But Kári was the father of Jökul [‘of ice’], the father of king Snär [‘snow’], but the children of king Snär were Thorri, Fönn [‘snow blown together’], Drifa [‘snowflake’] and Mjöll [‘fine snow’].

Saturn XLIII HATI

Gigantic Norse wolf, twin of Skoll. See Saturn XLVII SKOLL.

Saturn XLIV HYROKKIN

Norse giantess (“she who became wrinkled by the fire”) who launched Balder’s funeral ship.

Snorra Edda: Gylfaginning 59:

(After Bald[u]r’s death) the Aesir took the dead body and bore it to the seashore, where stood Baldur’s ship Hringhorn, which passed for the largest in the world. But when they wanted to launch it in order to make Baldur’s funeral pile on it, they were unable to make it stir. In this conjuncture they sent to Jontunheim for a certain giantess named Hyrokkin, who came mounted on a wolf, having twisted serpents for a bridle. As soon as she alighted, Odin ordered four Berserkir to hold her steed fast, who were, however, obliged to throw the animal on the ground ere they could effect their purpose. Hyrokkin then went to the ship, and with a single push set it afloat, but the motion was so violent that the fire sparkled from the rollers, and the earth shook all around. Thor, enraged at the sight, grasped his mallet, and but for the interference of the Aesir would have broken the woman’s skull.

Saturn XLV KARI

Norse wind giant.

Saemundar Edda: Hyndluliod 20:

(Hyndla to Ottar:) Ketil their friend was named, heir of Klyp; he was maternal grand-sire of thy mother. Then was Frodi yet before Kari, but the eldest born was Alf. (See also Saturn XLII FORNJOT.)

Saturn XLVI LOGE

In Norse mythology, Logi (“devouring flame”) was the embodiment of wild fire, and a master of quick eating.

Snorra Edda: Gylfaginning 47:

(The king, Utgard-Loki:) “... no one is permitted to remain here who does not, in some feat or other, excel all other men.”

“The feat I know,” replied Loki, “is to eat quicker than anyone else, and in this I am ready to give a proof against any one here who may choose to compete with me.”

“That will indeed be a feat,” said Utgard-Loki, “if thou performest what thou promisest, and it shall be tied forthwith.”

He then ordered one of his men, who was sitting at the further end of the bench, and whose name was Logi, to come forward and try his skill with Loki. A trough filled with flesh meat having been set on the hall floor, Loki placed himself at one end, and Logi at the other, and each of them began to eat as fast as he could, until they met in the middle of the trough. But it was found that Loki had only eaten the flesh, whereas his adversary had devoured both flesh and bone, and the trough to boot. All the company therefore adjured that Loki was vanquished.

Saturn XLVII SKOLL

Gigantic Norse wolf, twin of Hati.

Snorra Edda: Gylfaginning 12:

“There are two wolves,” answered Har; “the one called Skoll pursues the sun, and it is he that she fears, for he shall one day overtake and devour her; the other, called Hati (‘the hater’), the son of Hrodvitnir, runs before her, and as eagerly pursues the moon that will one day be caught by him.

“Whence come these wolves?” asked Gangleri.

“A hag,” replied Har, “dwells in the wood, to the eastward of Midgard, called Jarnvid (the Iron Wood ...). This old hag is the mother of many gigantic sons, who are all of them shaped like wolves, two of whom are the wolves you asked about ...”

Edda: Grímnismál 39:

The beast is named Skoll; it follows the shining goddess to the iron wood; Hati ('the hater'), the other wolf, son of Hrodwitnir [Fenrir] runs in front of the cheerful celestial bride [the moon; Hati will devour the moon and Skoll the sun].

Saturn XLVIII SURTUR

Surtr was the Norse leader of the fire giants, and son of Muspell.

Snorra Edda: Gylfaginning 4

(see also Saturn XLI FENRIR):

(Thridi to Gangleri:) First of all there was in the southern region (sphere) the world called Muspell. It is a world too luminous and glowing to be entered by those who are not indigenous there. He who sitteth on its borders (or the land's-end) to guard it is named Surt(u)r. In his hand he bareth a flaming falchion, and at the end of the world shall issue forth to combat, and shall vanquish all the gods, and consume the universe with fire.

Saturn XLIX ANTHE (Ανθή)

One of the Alkeonides, the daughters of the Giant Alkyoneos.

Suidas: Lexicon Graece et Latine,

see Saturn XXXII METHONE.

Saturn L JARNSAXA

Norse giantess, one of the nine mothers of Heimdall, the guard of Asgard.

Saemundar Edda: Hyndloliodh 35–37:

(Hyndla to Ottar, the favourite of Freya:) There was one born, in times of old, with wondrous might endowed, of origin divine: nine Jotun [giant] maids gave birth to the gracious god, at the world's margin.

Gialp gave him birth, Greip gave him birth, Eistla gave him birth, and Angein; Ulfron gave him birth and Eyrigiafa, Imd and Atla, and Jarnsaxa.

The boy was nourished with the strength of Earth, with the ice-cold sea, and with Son's blood.

Saturn LI GREIP

Norse giantess, one of the nine mothers of Heimdall, the guard of Asgard.

Saemundar Edda: Hyndloliodh 35–37,

see Saturn L JARNSAXA.

Saturn LII: TARQEQ

The Inuit moon spirit who dwells in the sky over the Frozen Reaches in a separate realm from the Air spirit.

Bellingham D (2001) *The Kingfisher Book of Mythology*. Kingfisher, New York, p. 19:

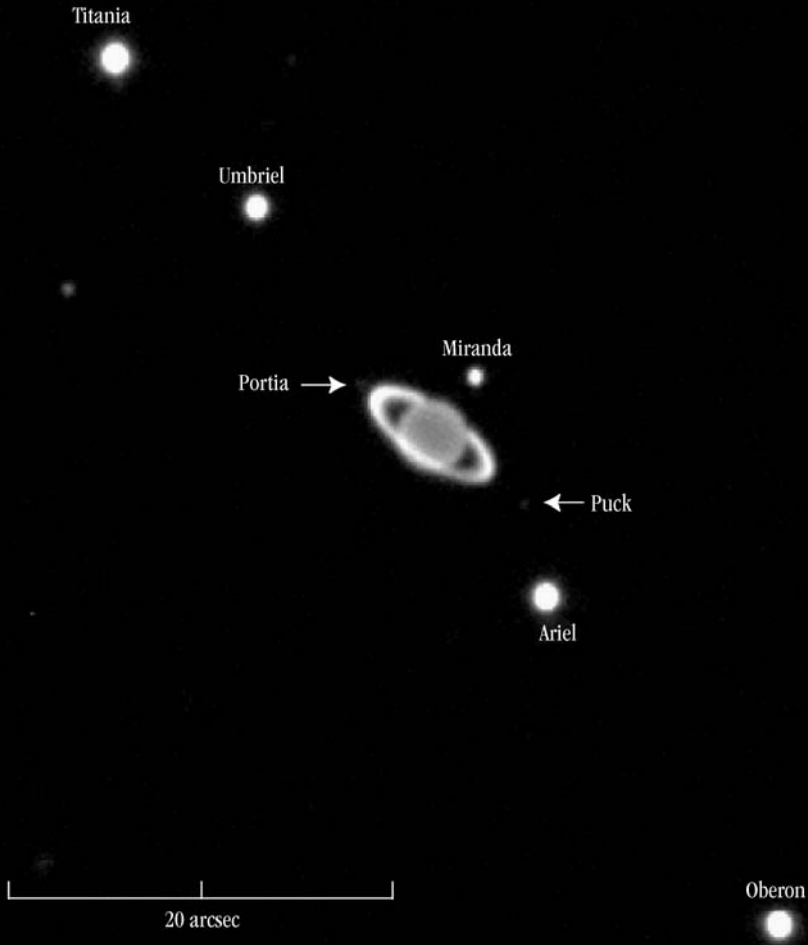
Tarqeq, the Inuit Moon spirit. He is a mighty hunter who lives in the sky and watches over human behavior. The Inuit of Alaska believe he controls the animals.



Tarqeq

Photograph on opposite page: A near-infrared view of the giant planet Uranus with rings and some of its moons, obtained on November 19, 2002, with the ISAAC multi-mode instrument on the 8.2-m VLT ANTU telescope at the ESO Paranal Observatory (Chile). Copyright ESO

The Satellites of Uranus



Uranus with Rings and Moons
(VLT ANTU + ISAAC)

ESO PR Photo 31b/02 (20 December 2002)

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The Satellites and Rings of Uranus

Discovering and Naming the Satellites

On January 11, 1787, about six years after he had discovered the seventh planet, William Herschel also identified the two largest Uranian satellites using his 40 ft (12 m) reflecting telescope at Slough. He numbered them, but abstained from individual names (1788, “An account on the discovery of two satellites revolving round the Georgian Planet,” in: *Philosophical Transactions of the Royal Society of London*, 78, 364–378). He later reported the discovery of another four satellites, one interior to, one intermediate between and two exterior to the two he identified originally (*ibidem* vol. 1798, PTRSL 88, 47–79). However, these four satellites were later found to be nonexistent; perhaps he confused them with stars.

It was 1834 before the two major satellites were again observed in Slough by John Herschel (1792–1871) with a 20-foot telescope, similar to that which had discovered them. On October 24, 1851, two (real!) additional moons were discovered by William Lassell (1799–1880) at Starfield near Liverpool, using a reflecting telescope that he made that had a 24"-diameter speculum metal mirror. All four satellites were later named. In his article “Beobachtungen der Uranus-Satelliten” (1852, *Astronomische Nachrichten*, 34, 325–328) Lassell writes:

In these tables I have for facility of Uranus proposed at my request by Sir John Herschel and selected by him names from fairly mythology. The most distant of the two bright satellites discovered in 1787 by Sir W. Herschel is denominated Oberon, the other Titania, and, pursuing still the order of distance, the inner ones now discovered are named Umbriel and Ariel.

In 1848, W. Lassell, using telescopes that he had constructed, established that only four satellites of Uranus existed. John Herschel commented in 1887 in his *Outlines of Astronomy* (Longman et al., London):

The satellites of Uranus require very powerful and perfect telescopes for their observation. Four are certainly known to exist, to which (proceeding from without, inwards in succession) the names Oberon, Titania, Umbriel and Ariel, of the fairies, sylphs, and gnomes of Shakespeare and Pope, have been assigned respectively.

(Oberon and Titania are the king and queen of the fairies in Shakespeare’s *A Midsummer Night’s Dream*, Umbriel is a gnome and Ariel a sylph in Pope’s *Rape of the Lock*; Ariel is also a spirit in Shakespeare’s *Tempest*, as also a rebellious angel in Milton’s *Paradise Lost*.) The original reservoir of names for the satellites of Uranus was restricted to fairies or spirits in English literature.

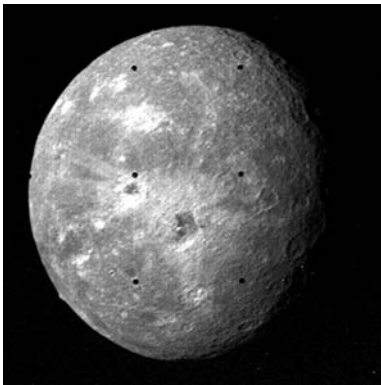
On February 16, 1948, at the 82 inch telescope at the McDonald Observatory at Mount Locke, Fort Davis, Texas, G.P. Kuiper photographed a fifth member of this

system of satellites and named it Miranda. In the June issue of the *Publication of the Astronomical Society of the Pacific*, he provides the reason for this choice of name as follows:

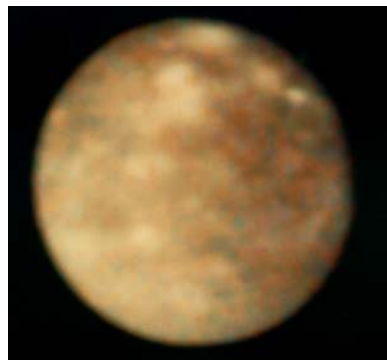
Uranus' own children, the Titans, are not suitable for mythological reasons; they have been assigned to the son of Uranus, Saturn (Kronos), who gained supreme power after wounding his father. Sir John Herschel named the four bright satellites Ariel, Umbriel, Titania, and Oberon. Oberon and Titania are the king and queen of the fairies in Shakespeare's *Midsummer Night's Dream*; Ariel and Umbriel occur in Pope's *Rape of the Lock*, while Ariel is also found in Shakespeare's *Tempest*. In the *Tempest* Ariel is an airy, tricky spirit, changing shape at will to serve Prospero, his master, while Miranda is a little cherub that did 'preserve me' (Prospero).

In 1985/86 the cameras of the interplanetary spacecraft Voyager 2, launched in 1977, obtained clear, high-resolution images of the known satellites and discovered 10 additional moons when it flew by Uranus on its grand tour of the outer solar system. The largest of these, discovered on 30 December by Stephen P. Synnott, was temporarily designated S/1985 U1 and later named Uranus XV Puck. The other moons discovered by Voyager were:

- S/1986 U1, discovered by Synnott on images taken on January 3, later named Uranus XII Portia
- S/1986 U2, discovered by Synnott on images taken on January 3, later named Uranus XI Juliet
- S/1986 U3, discovered by Synnott on images taken on January 13, later named Uranus IX Cressida
- S/1986 U4, discovered by Synnott on images taken on January 13, later named Uranus XIII Rosalind (misprinted as Rosalinda)



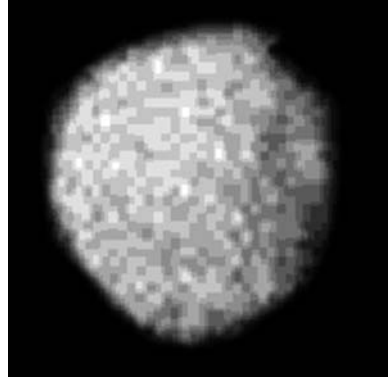
Voyager 2 images of Oberon taken on January 24, 1986, at a distance of 663,000 km. Copyright NASA/JPL



Voyager 2 color image of Titania taken on January 22, 1986, at a distance of 3.11 million km. Copyright NASA/JPL



Voyager 2 color composite of Miranda taken on January 27, 1986, from a distance of 147,000 km. Copyright NASA/JPL



Voyager 2 color picture of Puck taken on December 30, 1985. Copyright NASA/JPL

- S/1986 U5, discovered by Synnott on images taken on January 13, later named Uranus XIV Belinda
- S/1986 U6, discovered by Synnott on images taken on January 13, later named Uranus X Desdemona
- S/1986 U7, discovered by Richard J. Terrile on images taken on January 20, later named Uranus VI Cordelia
- S/1986 U8, discovered by R.J. Terrile on images taken on January 20, later named Uranus VII Ophelia
- S/1986 U9, discovered by Bradford A. Smith on images taken on January 23, later named Uranus VIII Bianca

The ten names for the Voyager 2 discoveries were chosen by an IAU subcommittee chaired by Tobias Owen “in keeping with a tradition established in the 19th century (...), names associated with characters in Shakespeare’s plays and Alexander Pope’s *The Rape of the Lock*.”

They were approved by the General Assembly of the IAU in 1988 in Baltimore (*Transactions of the IAU*, 20 A, 708).

The Voyager 2 inquiries seemed to demonstrate that Uranus was the only giant planet without an irregular satellite; the only one without bodies captured during its formation. Then on September 6, 1997, the first two irregular satellites were discovered by Brett J. Gladman, Phil Nicholson, J.A. Burns, and J.J. Kavelaars using the 200-inch Hale telescope, and given the temporary designations S/1997 U1 and S/1997 U2.

Three more irregular Uranian satellites were discovered on July 18, 1999, using the Canada–France–Hawaii telescope on Mauna Kea: S/1999 U1 by J.J. Kavelaars, B. Gladman, M. Holman, J.-M. Petit, H. Scholl; S/1999 U2 by B. Gladman, M. Holman, J.J. Kavelaars, J.-M. Petit, H. Scholl; and S/1999 U3 by M. Holman, J.J. Kavelaars, B. Gladman, J.-M. Petit, H. Scholl.

In May 1999, Erich Karkoschka (University of Arizona) discovered another object while comparing Voyager 2 images with those recently taken by the Hubble Space Telescope. It was given the temporary designation S/1986 S 10, indicating that it was the tenth moon of Uranus discovered in images taken in 1986. It was later named Uranus XXV Perdita.

In 2000, the names suggested by the discoverers of the five irregular satellites were approved by the 24th General Assembly of the IAU in Manchester (*Transactions of the IAU*, 24, 156):

- S/1997 U1 = Uranus XVI Caliban
- S/1997 U2 = Uranus XVII Sycorax
- S/1997 U3 = Uranus XVIII Prospero
- S/1999 U1 = Uranus XIX Setebos
- S/1999 U2 = Uranus XX Stephano

A sixth irregular satellite of Uranus, temporarily designated S/2001 U1, was found by Mat Holman, J.J. Kavelaars, and D. Milisavljevic with the 4-m reflector at the Cerro Tololo Inter-American Observatory (CTIO) on August 13, 2001. Confirmation images were obtained by Kavelaars with the Canada–France–Hawaii Telescope atop Mauna Kea on August 25, by P. Nicholson and C. Dumas with the 5-m Hale reflector at Palomar on September 21, and by J.-M. Petit with the 8.2-m telescope of the European Southern Observatory at Paranal, Chile, on November 15. It was then named Uranus XXI Trinculo, as proposed by the discoverers. On August 13, 2001, Matthew J. Holman, John J. Kavelaars, Dan Milisavljevic and Brett Gladman also discovered the outermost retrograde irregular satellite of Uranus, provisionally designated S/2001 U2, and the innermost retrograde irregular satellite of Uranus, provisionally designated S/2001, with the 4-m reflector of Cerro Tololo. After confirmation images were obtained, these satellites later were named Uranus XXIV Ferdinand and Uranus XXII Francisco.

In August 2003 three further irregular satellites of Uranus were discovered, bringing their total number to nine. On August 25, Marc Showalter and Jack J. Lissauer discovered two inner satellites which were given the temporary designations S/2003 U1 and S/2003 U2, and later the names Uranus XXVII Cupid and Uranus XXVI Mab, with the high-resolution channel of the Hubble Space Telescope. Four days later, on August 29, Scott S. Sheppard and David Jewitt discovered on images obtained from the Subaru 8.3 m telescope atop Mauna Kea an outer satellite that turned out to be the first prograde irregular satellite discovered around Uranus. It was given the temporary designation S/2003 U3 and later named Uranus XXIII Margaret.

Discovering and Naming the Rings

In 1797, 180 years before the rings of Uranus were officially discovered, the discoverer of this planet, William Herschel, reported on the two rings of Uranus he had observed

within ten years (*Philosophical Transactions of the Royal Society of London*, 1798, 47–90). On 4 March 1787 he observed a great ring R and a small ring r with his 20-foot reflector and noted that they “seem of a color a little indicated to red” (p. 68). He described the magnitude and the luminosity of the rings, and concluded from their temporary invisibility that “surmises of them should (...) be (...) reserved till superior instruments can be provided” (p. 48).

On 10 March 1977 James L. Elliot, Edward Dunham and Doug Mink, flying aboard NASA’s Kuiper Airborne Observatory (KAO) at 41,000 feet above the South Indian Ocean southwest of Australia, discovered the rings of Uranus when the planet occulted a ninth-magnitude star. They used the 36-inch reflector and high-speed photometer on the plane. Similar observations by ground-based observers at, e.g., Perth confirmed the results. For historical reasons, the rings (in order of increasing distance from the planet) were designated 6, 5, 4, Alpha, Beta, Eta, Gamma, Delta and Epsilon. Since 1977, many other stellar occultations have been observed from Earth, from which the physical properties of the rings have been derived with varying degrees of accuracy.

In 1986 Voyager successfully imaged the nine previously known rings, although they are some of the darkest objects ever studied. Discoveries included two new rings (provisionally designated 1986 U 1R and 1986 U 2R), as seen in ISS imaging data. The occultation data defined the dimensions and location of 1986 U 1R with a better precision than the ISS results. 1986 U 1R is a faint narrow ring about halfway between the rings Delta and Epsilon and very close to the orbit of Cordelia. This ring was finally named Lambda.

Two further rings—Uranus’s 12th and 13th, one colored blue and the other red—were discovered in December 2005 with the Hubble telescope and were confirmed using processed Voyager images. Announced in IAU Circular 8649, they were provisionally designated R/2003 U1 and R/2003 U2, and in October 2006 named Mu and Nu. The discoverers Mark R. Showalter and Jack D. Lissauer called these outermost rings and the satellites combined with them “the second ring-satellite system of Uranus” (2006, *Science*, 311, 5763, 973–977).

In April 2006 Imke de Pater announced that the outermost ring of Uranus and the outer ring E of Saturn with its satellite Enceladus are both blue in color. She suspects that both rings owe their blue color to subtle forces that allow the smaller particles in the rings to survive while larger ones are recaptured by the moon. Particles less than a tenth of a micron across scatter and reflect predominantly blue light (2006, *Science*, 312, 5770, 92–94). The blue Mu Ring is also known among scientists as the Mab Ring, as it is centered on the orbit of Mab. An excellent memory aid!

The ring 1986 U 2R (R/1986 U2) was confirmed by Imke de Pater in early 2007 and was named Zeta in April. On September 28, 2007, Imke de Pater and her team (H.B. Hammel, Mark R. Showalter, Marcos A. van Dam) reported (*Science*, 317, 5846, 1888–1890) that in the middle of 2007—when the rings of Uranus were oriented

edge-on to Earth for the first time since their discovery in 1977—a dramatic change occurred in the system. A broad cloud of faint material permeated the system but was not correlated with the narrow rings or with the embedded dust belts imaged by the Voyager spacecraft. De Pater concluded that the dust distribution within the system has changed substantially since the Voyager encounter in 1986. The Voyager images showed that the Zeta Ring surrounded the planet at a distance of about 35,000 km, but the latest infrared images from the Keck II telescope atop Mauna Kea show that the same ring is now at a distance of nearly 38,000 km.

In April 2007, Stuart Eves from Surrey Satellite Technology Limited (in Guildford, UK) confirmed at the National Astronomy Meeting in Preston (UK) that Herschel's information on the sizes, colors, luminosities, and temporary invisibility of the rings correlates well with Cassini's measurements of the rings.

The following table summarizes current data on the rings of Uranus, including their names, widths, thicknesses and the distance from the center of Uranus in km:

Name	Width (km)	Thickness (m)	Distance from the center of Uranus (km)
Zeta c	3,500	?	32,000–37,860
1986 U2R	2,500	?	37,000–39,500
Zeta	3,500	?	37,850–41,350
6	1.6–2.2	?	41,837
5	1.9–4.9	?	42,234
4	2.4–4.4	?	42,570
Alpha	4.8–10	?	44,718
Beta	6.1–11.4	?	45,661
Eta	1.9–2.7	?	47,175
Eta c	40	?	47,176
Gamma	3.6–4.7	150?	47,627
Delta c	10–12	?	48,300
Delta	4.1–6.1	?	48,300
Lambda	1–2	?	50,023
Epsilon	19.7–96.4	150?	51,149
Nu	3,800	?	66,100–69,900
Mu	17,000	?	86,000–103,000

(c = component of the ring)

Sources of Satellite Names

Uranus | ARIEL

*An airy spirit in Shakespeare's *The Tempest* (1611), a sylph in Pope's *The Rape of the Lock* (1712), and a rebellious angel in Milton's *Paradise Lost* (1667).*

Shakespeare: *The Tempest* 1,2:

(Prospero to Ariel:) Thou best know'st

What torment I did find thee in [he was confined by Sycorax into a cloven pine], thy groams

Did make wolves howl, and penetrate the breasts

Of ever-angry bears: it was a torment

To lay upon the damn'd which Sycorax

Could not again undo: it was mine art,

When I arrived and heard thee, that made gape

The pine, and let thee out.

(Ariel:) I thank thee, master.

(Prospero:) If thou more murmur'st, I will rend an oak,

And peg thee in his knotty entrails, till

Thou hast howl'd away twelve winters.

Ariel:) Pardon, master.

I will be correspondent to command,

And do my spiriting gently.

(Prospero:) Do so, and after two days

I will discharge thee.

Pope: *The Rape of the Lock* 1,103–110:

(Ariel:) This erring Mortals Levity may call,

Oh blind to Truth! the *Sylphs* contrive it all.

Of these am I, who thy Protection claim,

A watchful Sprite, and *Ariel* is my Name.

Late, as I rang'd the Crystal Wilds of Air,

In the clear Mirror of thy ruling *Star*

I saw, alas! Some dread Event impend,

Ere to the Main this Morning Sun descend.

Milton: *Paradise Lost* 6,359–372:

(The battle of God's angels against Satan and his angels:)

Nor stood unmindful Abdiel to annoy

The Atheist crew, but with redoubl'd blow

Ariel and Arioc, and the violence

Of Ramiel scorcht and blasted overthrew.

Uranus II UMBRIEL

A gnome or malevolent spirit in Pope's The Rape of the Lock (1712).

Pope: *The Rape of the Lock* 4,11–18 and 83–88:

For, that sad moment, when the *Sylphs*
withdrew,
And *Ariel* weeping from *Belinda* flew,
Umbriel, a dusky melancholy Spright,
As ever sully'd the fair face of Light,
Down to the Central Earth, his proper Scene,
Repair'd to search the gloomy Cave of *Spleen*.
Swift on his sooty Pinions flits the *Gnome*,
And in a Vapour reach'd the dismal
Dome. (...)

There she collects the Force of Female Lungs,
Sighs, Sobs, and Passions, and the War of Tongues.
A Vial next she fills with fainting Fears,
Soft Sorrows, melting Grievs, and flowing Tears.
The *Gnome* rejoicing bears her Gifts away,
Spreads his black Wings, and slowly mounts to Day.



Ariel and Umbriel

Uranus III TITANIA

The queen of the fairies in Shakespeare's A Midsummer Night's Dream (1595)

Shakespeare: *A Midsummer Night's Dream* 2,1:

(Oberon with his Train meeting Titania with hers:)

Ill met by moonlight, proud Titania.

(Titania:) What, jealous Oberon! Fairies, skip hence:

I have forsworn his bed and company.

(Oberon:) Tarry, rash wanton: am not I thy lord?

(Titania:) Then I must be thy lady: but I know

When thou hast stolen away from fairy-land,

And in the shape of Corin sat all day,

Playing on pipes of corn, and versing love

To amorous Phillida. Why art thou here,

Come from the farthest steppe of India,

But that, forsooth, the bouncing Amazon,

Your buskin'd mistress and your warrior love

To Theseus must be wedded? and you come

To give their bed joy and prosperity.

(Oberon:) How canst thou thus, for shame, Titania,

Glance at my credit with Hippolyta,

Knowing I know thy love to Theseus? (...)

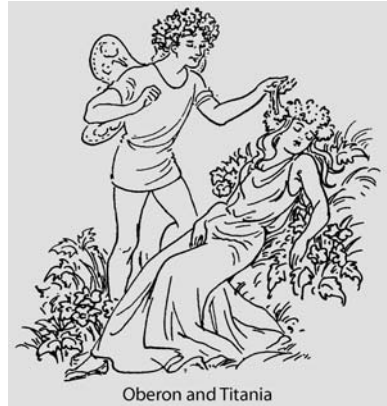
Uranus IV OBERON

The king of the fairies in Shakespeare's A Midsummer Night's Dream (1595)

Shakespeare: A Midsummer Night's Dream 2,1 and 4,1:

(Oberon to Puck:) Having once this juice
 [of a flower to be fetched by Puck],
 I'll watch Titania when she is asleep,
 And drop the liquor of it in her eyes.
 The next thing then she waking looks upon,
 Be it on lion, bear, or wolf, or bull,
 On meddling monkey or on busy ape
 She shall pursue it with the soul of love:
 And ere I take this charm from off her sight,
 As I can take it with another herb
 I'll make her render up her page [Theseus]
 to me.

But who comes here? I am invisible,
 And I will overhear their conference.
 (...) Welcome, good Robin. See'st thou this sweet sight?
 Her dotage now I do begin to pity.



Oberon and Titania

Uranus V MIRANDA

Heroine of Shakespeare's The Tempest (1611).

Shakespeare: The Tempest 3,1:

(Miranda to Ferdinand:) I do not know
 One of my sex, no woman's face remember,
 Save, from my glass, mine own, nor have I
 seen
 More that I may call men than you, good friend,
 And my dear father: how features are abroad,
 I am skillless of, but, by my modesty,
 The jewel in my dower, I would not wish
 Any companion in the world but you,
 Nor can imagination form a shape,
 Besides yourself, to like of. But I prattle
 Something too wildly, and my father's
 precepts
 I therein do forget.



Ariel and Miranda

Shakespeare: *The Tempest* 5,1:

(Ferdinand on Miranda:) (...) she's mine:
 I chose her when I could not ask my father
 For his advice, nor thought I had one. She
 Is daughter to this famous Duke of Milan,
 Of whom so often I have heard renown,
 But never saw before, of whom I have
 Received a second life, and second father
 This lady makes him to me.

Uranus VI CORDELIA

Daughter of Lear, King of Britain, in Shakespeare's King Lear (1608).

Shakespeare: *King Lear* 4,7:

(The mad Lear to Cordelia:) I fear I am not in my perfect mind.
 (...) I am mainly ignorant
 What place this is, and all the skill I have
 Remembers not these garments, nor I know not
 Where I did lodge last night. Do not laugh at me,
 For, as I am a man, I think this lady
 To be my child Cordelia.
 (Cordelia:) And so I am, I am.
 Lear:) Be your tears wet? Yes, faith. I pray, weep not:
 If you have poison for me, I will drink it.
 I know you do not love me, for your sisters
 Have, as I do remember, done me wrong:
 You have some cause, they have not.
 (Cordelia:) No cause, no cause.

Uranus VII OPHELIA

Daughter of Polonius, Lord Chamberlain, in Shakespeare's Hamlet, Prince of Denmark (1603).

Shakespeare: *Hamlet* 3,1:

(Hamlet to Ophelia:) ... the power of beauty will sooner transform honesty from what it is to a bawd than the force of honesty can translate beauty into his likeness: this was sometime a paradox, but now the time gives it proof. I did love you once.
 (Ophelia:) Indeed, my lord, you made me believe so.
 (Hamlet:) You should not have believed me, for virtue cannot so inoculate our old stock but we shall relish of it: I loved you not.

(Ophelia:) I was the more deceived.

(Hamlet:) Get thee to a nunnery: why wouldst thou be a breeder of sinners? I am myself indifferent honest, but yet I could accuse me of such things that it were better my mother had not borne me.

Uranus VIII BIANCA

Daughter of Baptista, a rich gentleman of Padua, in Shakespeare's The Taming of the Shrew (1623).

Shakespeare: The Taming of the Shrew 5,2:

(Lucentio welcomes the guests in his house:)
My fair Bianca, bid my father welcome,
While I with self-same kindness welcome thine,
Brother Petruchio, sister Katharina,
And thou, Hortensio, with thy loving widow,
Feast with the best, and welcome to my house:
My banquet is to close our stomachs up,
After our great good cheer. Pray you, sit down,
For now we sit to chat, as well as eat.

Uranus IX CRESSIDA

Daughter of Calchas (a Trojan priest who sides with the Greeks) in Shakespeare's Troilus and Cressida (1609).

Shakespeare: Troilus and Cressida 5,2:

(Troilus:) Ay, Greek, and that shall be divulged well
In characters as red as Mars his heart
Inflam'd with Venus: never did young man fancy
With so eternal and so fix'd a soul.
Hark, Greek: as much as I do Cressid love,
So much by weight hate I her Diomed,
That sleeve is mine that he'll bear on his helm,
Were it a casque compos'd by Vulcan's skill,
My sword should bite it. Not the dreadful spout
Which shipmen do the hurricano call,
Constring'd in mass by the almighty sun,
Shall dizzy with more camour Neptune's ear
In this descent than shall my prompted sword
Falling on Diomed.

Uranus X DESDEMONA

Daughter of Brabantio, a senator and wife to Othello, a noble Moor in service of the Venetian state, in Shakespeare's Othello, the Moor of Venice (1622).

Shakespeare: Othello 5,2:

(Othello to Desdemona:) ... confess thee freely of thy sin,
 For to deny each article with oath
 Cannot remove nor choke the strong conception
 That I do groan withal. Thou art to die.
 (Desdemona:) Then Lord have mercy on me!
 (Othello:) I say, amen.
 (Desdemona:) And have you mercy too! —I never did
 Offend you in my life, never loved Cassio
 But with such general warranty of heaven
 As I might love, I never gave him token.
 (Othello:) By heaven, I saw my handkerchief in his hand.
 O perjured woman! Thou dost stone my heart,
 And makest me call what I intend to do
 A murder, which I thought a sacrifice:
 I saw the handkerchief.
 (Desdemona:) He found it then,
 I never gave it him: send for him hither,
 Let him confess a truth.

Uranus XI JULIET

Heroine of Shakespeare's Romeo and Juliet (1597).

Shakespeare: Romeo and Juliet 5,3:

(Friar Laurence [who finally failed to help Juliet] to Escalus, Prince of Verona:)
 Romeo, there dead, was husband to that Juliet,
 And she, there dead, that Romeo's faithful wife:
 I married them, and their stol'n marriage-day
 Was Tybalt's doomsday, whose untimely death
 Banish'd the new-made bridegroom from this city,
 For whom, and not for Tybalt, Juliet pined.
 You, to remove that siege of grief from her,
 Betroth'd, and would have married her perforce,
 To County Paris: then comes she to me,
 And with wild looks bid me devise some mean
 To rid her from this second marriage (...)

Uranus XII PORTIA

Wife to Marcus Brutus, the conspirator against Julius Caesar, in Shakespeare's Julius Caesar (1599).

Shakespeare: Julius Caesar 2,1:

(Portia:) I grant I am a woman, but withal
 A woman that Lord Brutus took to wife,
 I grant I am a woman, but withal
 A woman well reputed, Cato's daughter.
 Think you I am no stronger than my sex,
 Being so father'd and so husbanded?
 Tell me your counsels, I will not disclose 'em.
 I have made strong proof of my constancy,
 Giving myself a voluntary wound (...)

Uranus XIII ROSALIND

Daughter of the banished Duke of Burgundy in Shakespeare's As You Like It (1623).

Shakespeare: As You Like It 1,3:

(Duke Frederick to Rosalind:) Mistress, despatch you with your safest haste
 And get you from our court. (...)
 (Rosalind:) Yet your mistrust cannot make me a traitor:
 Tell me whereon the likelihood depends.
 (Duke Frederick:) Thou art thy father's daughter, there's enough.
 (Rosalind:) So was I when your highness took this dukedom,
 So was I when your highness banish'd him:
 Treason is not inherited, my lord,
 Or, if we did derive it from our friends,
 What's that to me? My father was no traitor:
 Then, good my liege, mistake me not so much
 To think my poverty is treacherous. (...)
 (Duke Frederick:) ... Firm and irrevocable is my doom
 Which I have passed upon her, she is banish'd.

Uranus XIV BELINDA

Character in Pope's The Rape of the Lock (1712).

Pope: The Rape of the Lock 2,6–22:

(On Belinda:) ev'ry Eye was fix'd on her alone.
 On her white Breast a sparking Cross she wore,
 Which Jews might kiss, and Infidels adore.

Her lively Looks a sprightly Mind disclose,
 Quick as her Eyes, and as unfix'd as those:
 Favours to none, to all the Smiles extends,
 Oft she rejects, but never once offends.
 Bright as the Sun, her Eyes the Gazers strike,
 And, like the Sun, they shine on all alike.
 Yet graceful Ease, and Sweetness void of Pride,
 Might hide her Faults, if *Belles* had Faults to hide:
 If to her share some Female Errors fall,
 Look on her Face, and you'll forget 'em all.
 This Nymph, to the Destruction of Mankind,
 Nourish'd two Locks which graceful hung behind
 In equal Curls, and well conspir'd to deck
 With shining Ringlets the smooth Iv'ry Neck.

Uranus XV PUCK

A mischievous spirit being on duty for Oberon in Shakespeare's A Midsummer Night's Dream (1595).

Shakespeare: A Midsummer Night's Dream 2,1:

(Oberon to Puck:) ... a little western flower,
 Before milk-white, now purple with love's
 wound,

And maidens call it love-in-idleness.
 Fetch me that flower, the herb I shew'd thee
 once:

The juice of it on sleeping eyelids laid
 Will make or man or woman madly dote
 Upon the next live creature that it sees.
 Fetch me this herb, and be thou here again
 Ere the leviathan can swim a league.

(Puck:) I'll put a girdle round about the earth
 In forty minutes.



Shakespeare: A Midsummer Night's Dream 3,1:

(Puck:) I'll follow you, I'll lead you about a round,
 Through bog, through bush, through brake, through brier:
 Sometime a horse I'll be, sometime a hound,
 A hog, a headless bear, sometime a fire;
 And neigh, and bark, and grunt, and roar, and burn,
 Like horse, hound, hog, bear, fire, at every turn.

Uranus XVI CALIBAN

A deformed monster; Prospero's slave in Shakespeare's The Tempest (1611).

Shakespeare: The Tempest 1,2:

(Caliban to Prospero:) (...) This island's mine, by Sycorax my mother,
Which thou takest from me. When thou camest first,
Thou strokedst me, and madest much of me, wouldst give me
Water with berries in't, and teach me how
To name the bigger light, and how the less,
That burn by day and night: and then loved thee,
And show'd thee all the qualities o' th' isle,
The fresh springs, brine-pits, barren place and fertile:
Cursed be I that did so! All the charms
Of Sycorax, toads, beetles, bats, light on you!
For I am all the subjects that you have,
Which first was mine own king: and here you sty me
In this hard rock, whiles you do keep from me
The rest o' th' island.

Uranus XVII SYCORAX

A witch; mother of Caliban in Shakespeare's The Tempest (1611).

Shakespeare: The Tempest 1,2:

(Prospero to Ariel:) The foul witch Sycorax, who with age and envy
Was grown into a hoop? (...) Where was she born? Speak, tell me.
(Ariel:) Sir, in Argier [Algiers].
(Prospero: O, was she so? I must
Once in a month recount what thou hast been,
Which thou forget'st. This damn'd witch Sycorax,
For mischiefs manifold, and sorceries terrible
To enter human hearing, from Argier,
Thou know'st, was banish'd for one thing she did
They would not take her life. Is not this true?
(Ariel:) Ay, sir.
(Prospero:) This blue-eyed hag was hither brought with child,
And here was left by the sailors. Thou, my slave,
As thou report'st thyself, wast then her servant,
And, for thou wast a spirit too delicate
To act her earthy and abhorr'd commands,
Refusing her grand hests, she did confine thee.
By help of her more potent ministers,
And in her most unmitigable rage,
Into a cloven pine, within which rift

Imprison'd thou didst painfully remain
 A dozen years, within which space she died,
 And left thee there, where thou didst vent thy groans
 As fast as mill-wheels strike. Then was this island —
 Save for the son that she did litter here.

Uranus XVIII PROSPERO

The exiled Duke of Milan in Shakespeare's The Tempest (1611).

Shakespeare: The Tempest 1,2:

(Prospero to Miranda:) The King of Naples, being an enemy
 To me inveterate, hearkens my brother's suit;
 Which was, that he, in lieu o' the premises,
 Of homage and I know not how much tribute,
 Should presently extirpate me and mine
 Out of the dukedom, and confer fair Milan,
 With all the honours, on my brother: whereon,
 A treacherous army levied, one midnight
 Fated to the purpose, did Antonio open
 The gates of Milan, and, i' the dead of darkness,
 The ministers for the purpose hurried thence
 Me and thy crying self.

Uranus XIX SETEBOS

A god worshipped by Sycorax in Shakespeare's The Tempest (1611). In Richard Eden's History of Travayle (1577), Setebos is given as the name of a god or diabolical being worshipped by the Patagonians.

Shakespeare: The Tempest 1,2; 5,1:

(Caliban on Prospero:) I must obey; his art is of such power,
 It would control my dam's [mother's] god, Setebos,
 And make a vassal of him.
 (...) O Setebos ... How fine my master is! I am afraid
 He will chastise me.

Uranus XX STEPHANO

A drunken butler in Shakespeare's The Tempest (1611).

Shakespeare: The Tempest 2,2:

(Caliban to Stephano:) Hast thou not dropp'd from heaven?
 (Stephano:) Out o' the moon, I do assure thee: I was the man i' the moon when time was.
 (Caliban:) I have seen thee in her, and I do adore thee: my mistress show'd me thee,
 and thy dog, and thy bush.

Shakespeare: *The Tempest* 5,1:

(Caliban on Stephano:) What a thrice-double ass
Was I, to take this drunkard for a god,
And worship this dull fool!

Uranus XXI TRINCULO

A jester in Shakespeare's The Tempest (1611).

Shakespeare: *The Tempest* 2,2:

(Trinculo:) Stephano! If thou beest Stephano, touch me, and speak to me, for I am Trinculo—be not afeard—thy good friend Trinculo.

(Stephano:) If thou beest Trinculo, come forth: I'll pull thee by the lesser legs: if any be Trinculo's legs, these are they. Thou art very Trinculo indeed! How camest thou to be the siege of this mooncalf [Caliban]? Can he vent Trinculos?

Uranus XXII FRANCISCO

A lord in Shakespeare's The Tempest (1611).

Shakespeare: *The Tempest* 2,1:

(Francisco witnesses to Alonso Ferdinand's rescue:) ... his bold head
'Bove the contentious waves he kept, and oar'd
Himself with his good arms in lusty stroke
To the shore, that o'er his wave-worn basis bow'd,
As stooping to relieve him: I do not doubt
He came alive to land.

Uranus XXIII MARGARET

Gentlewoman who attends to Hero, daughter of Leonato, Governor of Messina, in Shakespeare's Much Ado About Nothing (1600).

Shakespeare: *Much Ado About Nothing* 3,4:

(Hero to Margaret, on her dress:) God give me joy to wear it! For my heart is exceeding heavy.

(Margaret:) 'T will be heavier soon by the weight of a man.

(Hero:) Fie upon thee! art not ashamed?

(Margaret:) Of what, lady? Of speaking honourably? Is not marriage honourable in a beggar? Is not your lord honourable without marriage? I think you would have me say, "saving your reverence, a husband:" an bad thinking do not wrest true speaking, I'll offend nobody: is there any harm in "the heavier for a husband?" None, I think, an it be the right husband and the right wife, otherwise 'tis light, and not heavy (...)

Uranus XXIV FERDINAND

Son of Alonso, King of Naples, in Shakespeare's The Tempest (1611).

Shakespeare: The Tempest 3,1:

(Ferdinand to Miranda:) I am, in my condition,
A prince, Miranda, I do think, a king,
I would, not so! And would no more endure
This wooden slavery than to suffer
The flesh-fly blow my mouth. Hear my soul speak:
The very instant that I saw you, did
My heart fly to your service; there resides,
To make me slave to it; and for your sake
And I this patient log-man.

Uranus XXV PERDITA

Daughter of the King of Sicily in Shakespeare's The Winter's Tale (1611).

Shakespeare: The Winter's Tale 4,1:

(Time:) Gentle spectators, that I now may be,
In fair Bohemia, and remember well,
I mentioned a son o' he king's, which Florizel
I now name to you, and with speed so pace
To speak of Perdita, now grown in grace
Equal with wondering: what of her ensues,
I list not prophesy, but let Time's news
Be known when 'tis brought forth. A shepherd's daughter,
And what to her adheres, which follows after,
Is th' argument of Time. Of this allow,
If ever you have spent time worse ere now,
If never, yet that Time himself doth say
He wishes earnestly you never may.

Uranus XXVI MAB

The queen of the fairies in Shakespeare's Romeo and Juliet (1597).

Shakespeare: Romeo and Juliet 1,4:

(Mercutio to Romeo:) Mab ... is the fairies' midwife, and she comes
In shape no bigger than an agate-stone
On the forefinger of an alderman,
Drawn with a team of little atomies
Athwart men's noses as they lie asleep:

Her waggon-spokes made of long spinners' legs,
The cover, of the wings of grasshoppers,
Her traces, of the smallest spider's web,
Her collars, of the moonshine's watery beams,
Her whip, of cricket's bone, the lash, of film,
Her waggoner, a small grey-coated gnat,
Not half so big as a round little worm
Prick'd from the lazy finger of a maid:
Her chariot is an empty hazel-nut,
Made by the joiner squired or old grub,
Time out o' mind the fairies' coach-makers.
And in this state she gallops night by night
Through lovers' brains, and then they dream of love (...).

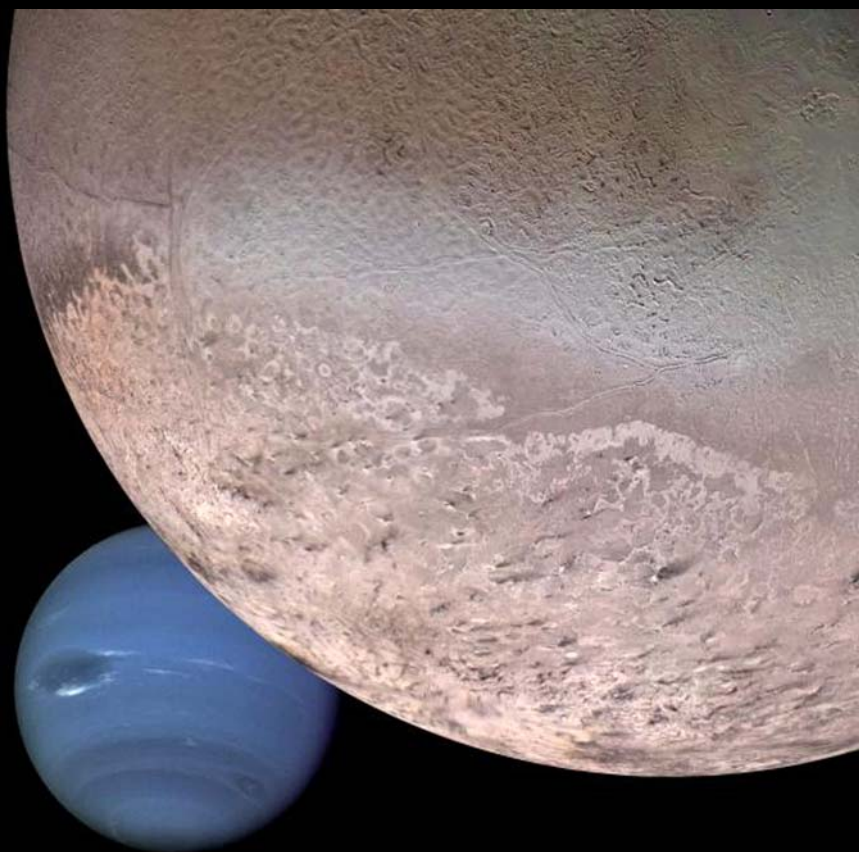
Uranus XXVII CUPID

Masked character in Shakespeare's Timon of Athens (1608), and not named after Cupid (Amor) in Shakespeare's other plays (A Midsummer Night's Dream, The Tempest, Romeo and Juliet, King Lear, Othello, Troilus and Cressida, etc.).

Shakespeare: Timon of Athens 1,2:

(Cupid, seducing the noble Athenian Timon to waste his fortune:)
Hail to thee, worthy Timon, and to all
That of his bounties taste! The five best senses
Acknowledge thee their patron, and come freely
To gratulate thy plenteous bosom: th' ear,
Taste, touch, and smell, pleases'd from thy table rise,
These only now come but to feast thine eyes.

The Satellites of Neptune



The Satellites and Rings of Neptune

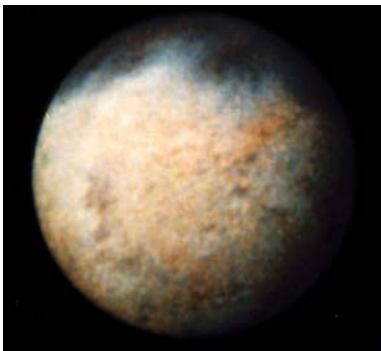
Discovering and Naming the Satellites

The 13 satellites of Neptune were discovered between 1846 and 2003 and named after the retinue of the god of the sea.

The first of them, discovered by William Lassell on October 10, 1846, using his 24-inch reflector near Liverpool, remained unnamed for a long time for not before the latter part of the 19th century and the early 20th century, extensive measurements of the position of this satellite were made by several astronomers (1978, *Sky and Telescope*, 55, 4, p. 285). However, in his *Astronomie populaire* (1880, Paris) and *Himmelskunde für das Volk* (1881, Zahn, Neuenburg, vol. 2, pp. 410 and 456), Camille Flammarion proposed the name Triton, which was generally used in the twentieth century:

This celestial body until now did not receive a name; there is, however, no lack of sons of the god: the name 'Triton', one of the most successful companions of his father on the ocean, could be well befitting for it. It is probable that this distant planet is accompanied by a number of satellites.

The second satellite of Neptune, discovered on May 1, 1949, using the 82-inch reflector of the McDonald Observatory at Mount Locke, Fort Davis, Texas, received its name in a relatively short time from its discoverer. In 1949 (*Publications of the Astronomical Society of the Pacific*, 61, 361, 176), G.P. Kuiper writes: "It is suggested that the name Nereid be used for Neptune II. The Nereids were sea nymphs who, together with the Tritons, were the attendants of Neptune." They are associated with the painting *Triton and Nereid* by Arnold Böcklin.



False color image of Neptune's largest satellite, Triton, taken by Voyager 2 early in the morning of August 23, 1989. Copyright NASA



Global color mosaic of the southern hemisphere of Triton, created from images taken by Voyager 2 during its flyby on August 25, 1989. Copyright NASA/JPL

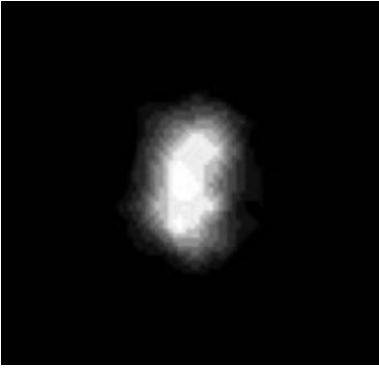


Image of Nereid taken by Voyager 2 on August 25, 1989, at a distance of 4.7 million km. Copyright NASA/JPL.



Three satellites of Neptune on a image taken by the Voyager 2 spacecraft on August 21, 1989, at a distance of 5.9 million km (exposure time 15 s): Despina (1989 N3/Neptune V), Thalassa (1989 N5/Neptune IV), Naiade (1989 N6/Neptune III). Copyright NASA/JPL.

While Nereid orbits within the orbit of Triton—both are irregular satellites—six further satellites of Neptune, all regular and orbiting within the orbit of Triton, were discovered during the Voyager 2 flyby in 1989. The outermost of them, provisionally designated S/1989 N1, was spotted by S.P. Synnott in July in Voyager 2 images taken mid-June. On August 3, less than two weeks after this moon had been identified, three more satellites were announced, S/1989 N2, detected by H. Reitsema, W. Hubbard, L. Lebofsky, and O. Tholen, and S/1989 N3 and S/1989 N4, detected by S.P. Synnott. On its final approach to Neptune, pictures were taken in which R. Terrile identified the two innermost satellites S/1989 N5 and S/1989 N6.

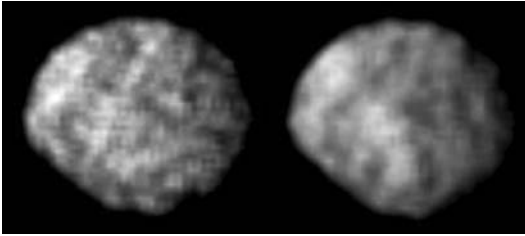
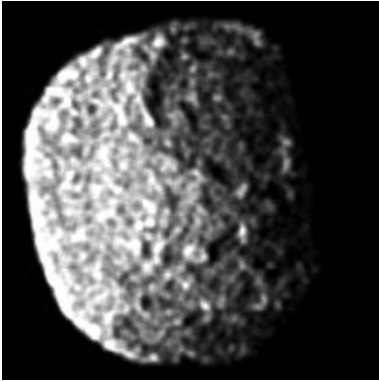


Image of Larissa, acquired by the Voyager 2 spacecraft on August 24, 1989. Copyright NASA/JPL



Proteus, from Voyager 2 images taken on August 25, 1989 at a distance of 146,000 km. Copyright NASA/JPL

The final names of the newly discovered satellites were approved in July 1991 by the General Assembly in Buenos Aires, Argentina (*Transactions of the IAU*, 21A, 614). They received Roman numerals and names from Neptune's retinue:

S/1989 N6 Neptune III Naiad
S/1989 N5 Neptune IV Thalassa

S/1989 N3 Neptune V Despina
S/1989 N4 Neptune VI Galatea
S/1989 N2 Neptune VII Larissa
S/1989 N1 Neptune VIII Proteus

In 2002 and 2003, another five satellites were discovered, all of which were irregular and orbiting outside the orbit of Nereid. Three of the satellites, discovered on August 14, 2002 by Matt Holman, John J. Kavelaars, T. Grav, W. Frasnser, and D. Milisavljevic, were provisionally designated S/2002 N 1, S/2002 N2, and S/2002 N3. To locate these new moons, Holman and Kavelaars utilized an innovative technique. Using the 4.0-meter Blanco telescope at the Cerro Tololo Inter-American Observatory, Chile, and the 3.6-meter Canada-France-Hawaii telescope, Hawaii, they took multiple exposures of the sky surrounding the planet Neptune. After digitally tracking the motion of the planet as it moved across the sky, they then added many frames together to boost the signals from any faint objects. Since they tracked the planet's motion, stars showed up as streaks of light in the final combined image, while the satellites accompanying the planet appeared as points of light.

An outer satellite, discovered on August 29, 2003, by Scott Sheppard, D.C. Jewitt, and J. Kleyna in Mauna Kea, was designated S/2003 N1, and the outermost of these satellites, discovered by Matthew J. Holman and Brett Gladman on August 14, 2002 in Cerro Tololo, was designated S/2002 N4 (2004, *Nature*, 430, 865–867).

In early 2007 the new moons received Roman numerals and were finally named after the Nereids in Greek mythology:

S/2001 N1 Neptune IX Halimede
S/2002 N2 Neptune XI Sao
S/2002 N3 Neptune XII Laomedeia
S/2003 N1 Neptune X Psamathe
S/2002 N4 Neptune VIII Neso

Two of the satellite names were already in use as names of minor planets: (74) Galatea and (162) Larissa. At the General Assembly of the IAU in Buenos Aires, the Commission 20 (which is charged with naming minor planets) and the IAU Working Group for Planetary System Nomenclature agreed to work more closely together and to stop duplicating effort in the future. As commission member Brian Marsden noted (1991, *Sky and Telescope*, 82, 6, 586): “We don’t want to take naming privileges away from the discoverers, provided they act responsibly.”

Discovering and Naming the Rings

A Neptunian ring was first observed by William Lassell with the 24-inch Newtonian reflector at his Starfield Observatory at Liverpool. A drawing of its aspect on October 10, 1846, was published in *Astronomische Nachrichten* (no. 589). Aside from some remarks by James Challis (1847, *Astronomische Nachrichten*, nos. 591 and 596), the possibility of a ring around Neptune was then overlooked for a long time. Finally, in 1983 and 1984, rings and ring arcs around Neptune were detected in ground-based stellar occultation experiments and then confirmed by the cameras on Voyager 2. The Voyager images show three brighter rings (provisionally designated 1989 N1R to N3R), as well as three particle rings or arcs in the outermost ring 1989 N1R, which are associated with the inner moons orbiting Neptune.

The final names of the newly discovered rings of Neptune were approved in July 1991 by the Executive Committee of the IAU at the General Assembly in Buenos Aires, Argentina (*Transactions of the IAU*, 21A, 614). The rings were named after the joint discoverers of Neptune (Johann Gottfried Galle, 1812–1910, Urbain Jean Leverrier, 1811–1877, Jean Couch Adams, 1819–1892):

1989 N1 Adams
1989 N2R Leverrier
1989 N3R Galle

The IAU also gave formal recognition to the names Liberté, Égalité, and Fraternité, suggested as an aid to memorizing the “leading”, “equidistant” and “following” ring

arcs by WGPSN member André Brahic, who is among those credited with their discovery (1991, *Transactions of the International Astronomical Union*, XXI B, 363).

After further observations of the Neptunian rings, the Voyager 2 team identified a fourth ring (provisionally designated 1989 NR4), and worked out that another 1989 NR4 ring originally identified as a faint ring extending outward of 1989 NR2 was an independent ring. An additional arc, C, was also identified. The two independent rings 1989 NR4 were finally named after the discoverer of Triton, William Lassell (1799–1880) and the director of the Paris Observatory Dominique Francois Jean Arago (1786–1853), and Arc C was named Courage at the IAU General Assembly in The Hague in 1994 (*Transactions of the International Astronomical Union*, XXII B, 231). A table listing the named rings and the arcs in Adams Ring as well as their distances from the center of the planet (Neptune's equatorial radius is 24,766 km) is given below.

Ring/arc	Distance from the center of Neptune (km)
Galle (1989 N3R)	~ 41,900
Le Verrier (1989 N2R)	~ 53,200
Lassell (1989 N4R)	~ 53,200
Arago (1989 N4R)	~ 57,200
Unnamed (indistinct)	61,950
Adams (1989 N1R)	62,933
<i>Courage</i>	62,933
<i>Liberté</i>	62,933
<i>Égalité 1</i>	62,933
<i>Égalité 2</i>	62,933
<i>Fraternité</i>	62,933

Sources of Satellite Names

Neptune I TRITON (ΤΡΙΤΩΝ)

Triton, the embodiment of the roaring of the sea, is the son of Poseidon and Amphitrite and dwells with them in a golden palace beneath the waves, although he is also known specifically as the ruler of a large lake in Libya that was named after him.

Apollonius Rhodius: *The Argonautica* 4,1537–1578:

(After having conquered the golden fleece in Colchis the Argonauts were driven by a storm into Lake Triton. Their spokesman Euphemus addressed to him and immediately) before them stood, in the form of a youth, far swaying Triton, and he lifted a clod from the earth and offered it as a stranger's gift, and thus spoke:

“Take it, friends, for no stranger’s gift of great worth have I here by me now to place in the hands of those who beseech me. But if ye are searching for a passage through this sea, as often is the need of men passing through a strange land, I will declare it. For my sire Poseidon has made me to be well versed in this sea. And I rule the shore—if haply in your distant land you have ever heard of Eurypylus, born in Libya, the home of wild beasts.”



Tritonide, Triton

Thus he spake, and readily Euphemus held out his hands towards the clod, and thus addressed him in reply (asking to show him a passage in order to get home to the Peloponnesus) and Triton stretched out his hand and showed afar the sea and the lake’s deep mouth, and then addressed them: “That is the outlet to the sea, where the deep water lies unmoved and dark; on each side roll white breakers with shining crests; and the way between for your passage out is narrow. And that the sea stretches away in mist to the divine land of Pelops beyond Crete ...

Neptune II NEREID (Νηρηϊδες)

Any of the fifty daughters of the sea god Nereus. Soft girls accompanying Poseidon as also the sea goddess Thetis. Being benign to mankind, they are ready to aid storm-tossed sailors.

Hesiodus: Theogonia 233–264:

And Sea begat Nereus, who is true und lies not: and men call him the Old Man because he is trusty and gentle and does not forget the laws of righteousness, but thinks just and kindly thoughts. And yet again he got great Thaumatas and proud Phorcys, being mated with Earth, and fair-cheeked Ceto and Eurybia who has a heart of flint within her.



Nereid on a Hippokamp

And of Nereus and rich-haired Doris, daughter of Ocean the perfect river, were born children, passing lovely amongst goddesses, Ploto, Eucrante, Sao, and Amphitrite, and Eudora, and Thetis, Galene and Glauce, Cymothoë, Speo, Thoë and lovely Halie, and Pasithea, and Erato, and rosy-armed Eunice, and gracious Melite, and Eulimene, and Agaue, Doto, Proto, Pherusa, and Dynamene, and Nisaea, and Actaea, and Protomedea, Doris, Panopea, and comely Galatea, and lovely Hippothoë, and rosy-armed Hipponoë, and Cymodoce who with Cymatolege and Amphitrite easily calms the waves upon the misty sea and the blasts of raging winds, and Cymo, and Eione, and rich-crowned Halimede, and Glauconome, fond of laughter, and Pontoporea, Leagore, Euagore, and Laomedea (Greek Laomedea), Polynoë, and Autonoë, and

Lysianassa, and Euarne, lovely of shape and without blemish of form, and Psamathe of charming figure and divine Menippe, Neso, Eupompe, Themisto, Pronoë, and Nemeretes who has the nature of her deathless father. These fifty daughters sprang from blameless Nereus, killed in excellent crafts.

Apollodorus: Bibliotheca 1,2,7:

To Nereus and Doris were born the Nereids, whose names are Cymothoe, Spio, Glauconome, Nausithoe, Halie; Erato, Sao, Amphitrite, Eunice, Thetis, Eulimene, Agave, Eudore, Doto, Pherusa, Galatea, Actaea, Pontomedusa, Hippothoe, Lysianassa, Cymo, Eione, Halimede, Plexaure, Eucrante, Proto, Calypso, Panope, Cranto, Neomeris, Hipponoe, Ianira, Polynome, Autonoe, Melite, Dione, Nesaea, Dero, Euagore, Psamathe, Eumolpe, Ione, Dynamene, Ceto, and Limnoria.

Apollonius Rhodius: Argonautica 4,937–955:

So the Nereids darted upward and circled in their ranks round the ship Argo, while Thetis guided its course. And when they were about to touch the Wandering rocks, straightway they raised the edge of their garments over their snow-white knees, and aloft, on the very rocks and where the waves broke, they hurried along on this side and on that apart from one another. And the ship was raised aloft as the current smote her, and all around the furious wave mounting up broke over the rocks, which at one time touched the sky like towering crags, at another, down in the depths, were fixed fast at the bottom of the sea and the fierce waves poured over them in floods. And the Nereids, even as maidens near some sandy beach roll their garments up to their waists out of their way and sport with a shapely-rounded ball; then they catch it one from another and send it high into the air; and it never touches the ground; so they in turn one from another sent the ship through the air over the waves, as it sped on ever away from the rocks; and round them the water spouted and foamed.

Neptune III NAIAD (αἰας/Νηϊας; “fountain”)

Any nymph of flowing water (grottos, springs, fountains, brooks, rivers, lakes); benevolent, but biased in wars.

Homerus: Hymn to Aphrodite 256–263:

(Aphrodite’s child Aineias) will be nursed by the deep-bosomed, mountain-couching nymphs who dwell on this great and holy mountain, who belong with neither mortals nor gods. They have long lives, and eat divine food, and step the fair dance with the immortals; Sileni and the keen-sighted Argus-slayer unite in love with them in the recesses of lovely caves.

Ovidius: Metamorphoses 14,546–565:

The all-fostering mother (Cybele) broke the hempen fastenings of the Phrygian ships and, forcing them head down, plunged them beneath the water. Straightway the wood

softened and turned to flesh, the ships' curved prows changed to heads, the oars to toes and swimming legs; what had been body before remained as body and the deep-laid keel was changed into a spine; cordage became soft hair, and sail-yards, arms; the sea-green colour was unchanged. And now, as water-nymphs, with maiden glee they sport in the waters which they feared before. Though born on the rough mountaintops, they now throng the yielding waves and no trace of their first state troubles them. And yet, remembering the many perils they have often suffered on the deep, they often place helping hands beneath storm-tossed barques, except such as carried Greeks. Remembering still the Phrygian calamity, they hated the Pelasgian race and they rejoiced to see the broken timbers of Ulysses' ship, rejoiced to see the vessel of Alcinoüs grow stiff and its wood turn to stone...

Homerus: *Odyssea* 13,9:

There is in the land of Ithaca a certain haven of Phorcys. At the head of the harbor is a long-leaved olive-tree, and near it is a pleasant cave sacred to the nymphs that are called the Naiads. And therein are mixing bowls and jars of stone, and there too the bees store honey. And in the cave are long looms of stone, at which the nymphs weave purple webs, a marvel to behold, and in it are also overflowing springs.

Neptune IV THALASSA (Θαλασσα; "the sea")

Goddess of the sea; regarded as the embodiment of the Mediterranean, she corresponds to the male Pontus. Mother of Aphrodite by Uranus and of the web-footed Telchines by Oceanus.

Hyginus *Fabulae* ed. Schmidt, *Praefatio* 9,17:

The children of Ether and Day were Earth, Sky and Sea.

Diodorus Siculus 5,55:

The island which is called Rhodes was first inhabited by the people who were known as Telchines; these were children of Thalatta [Thalassa in the Attic dialect], as the mythical tradition tells us, and the myth relates that they, together with Capheira, the daughter of Oceanus, nurtured Poseidon, whom Rhea committed as a babe to their care.

Neptune V DESPINA (Δεσποίνα "mistress")

A nymph, daughter of Poseidon and Demeter.

Pausanias 8 (*Arcadia*) 37,1-3, 8-11:

From Acacesium it is four stades to the sanctuary of the Mistress. First in this place is a temple of Artemis Leader, with a bronze image, holding torches, which I conjecture to be about six feet high. From this place there is an entrance into the sacred enclosure of the Mistress (...) In front of the temple is an altar to Demeter and another to the

Mistress, after which is one of the Great Mother. The actual images of the goddesses, Mistress and Demeter, the throne on which they sit, along with the footstool under their feet, are all made out of one piece of stone. (...)

When you have gone up a little, beside the temple of the Mistress on the right is what is called the Hall, where the Arcadians celebrate mysteries, and sacrifice to the Mistress many victims in generous fashion. Every man of them sacrifices what he possesses. But he does not cut the throats of the victims, as is done in other sacrifices; each man chops off a limb of the sacrifice, just that which happens to come to hand. This Mistress the Arcadians worship more than any other god, declaring that she is a daughter of Poseidon and Demeter. Mistress is her surname among the many, just as they surname Demeter's daughter by Zeus the Maid. But whereas the real name of the Maid is Persephone, as Homer and Pamphos before him say in their poems, the real name of the Mistress I am afraid to write to the uninitiated. Beyond what is called the Hall is a grove, sacred to the Mistress and surrounded by a wall of stones, and within it are trees, including an olive and an evergreen oak growing out of one root, and that not the result of a clever piece of gardening. Beyond the grove are altars of Horse Poseidon, as being the father of the Mistress, and of other gods as well.

Neptune VI GALATEA (Γαλατεία; "the milk-white one")

A Nereid, lover of Pan's son Acis who was pursued by the jealous cyclops Polyphemus.

Ovidius: *Metamorphoses* 13,789–799:

Acis praises: "O Galatea, whiter than snowy privet-leaves, more blooming than the meadows, surpassing the alder in your tall slenderness, more sparkling than crystal, more frolicsome than a tender kid, smoother than shells worn by the lapping waves, more welcome than the winter's sun and summer's shade, more goodly than orchard-fruit, fairer than the tall plane-tree, more shining-clear than ice, sweeter than ripened grapes, softer than swan's down and curdled milk, and, if only you would not flee from me, more beauteous than a well-watered garden."

Ovidius: *Metamorphoses* 13,870–897:

(Galatea on Polyphemus' vain efforts:) "Such vain complaints he uttered, and rose up (I saw it all), just as a bull which, furious when the cow has been taken from him, cannot stand still, but wanders through the woods and familiar pasturelands. Then the fierce giant spied me and Acis, neither knowing nor fearing such a fate, and he cried: 'I see you, and I'll make that union of your loves the last.' His voice was big and terrible as a furious Cyclops' voice should be. Aetna trembled with the din of it. But I, in panic fright, dived into the near-by sea. My Symaethian hero had already turned to run, and cried: 'Oh, help me, Galatea, I pray; help me, my parents, and take me, doomed now to perish, to your kingdom.' Cyclops ran after him and hurled a piece wrenched from the mountainside; and, although the merest edge of the rock reached Acis, still it was enough to bury him altogether. But I (the only thing that

fate allowed to me) caused Acis to assume his ancestral powers. Crimson blood came trickling from beneath the mass; then in a little while its ruddy colour began to fade away and it became the colour of a stream swollen by the early rains, and it cleared entirely in a little while. Then the mass that had been thrown cracked wide open and a tall, green reed sprang up through the crack, and the hollow opening in the rock resounded with leaping waters, and, wonderful! Suddenly a youth stood forth waist-deep from the water, his new-sprung horns wreathed with bending rushes. The youth, save that he was larger and his face of dark sea-blue, was Acis. But even so he still was Acis, changed to a river-god; and his waters kept their former name.”

Neptune VII LARISSA (Λαρίσα; “the hovering”)

A nymph, Neptune’s lover who ultimately did not want to be seduced by him.

Dionysius Halicarnassus 1,17,2–3:

(The Pelasgians) received their name originally from Pelasgus, their king ... afterwards, leaving the Peloponnesus, they removed to the country which was then called Haemonia and now Thessaly. The leaders of the colony were Achaeus, Phtius and Pelasgus, the sons of Larissa and Poseidon. When they arrived in Haemonia they drove out the barbarian inhabitants and divided the country into three parts, calling them, after the names of their leaders, Phthiotis, Achaia and Pelasgiotis.

Ovidius: Metamorphoses 2,542–595:

In all Thessaly there was no fairer maid than Coronis of Larissa. (She was, however already no longer a virgin, when she told:) “I once was a king’s daughter, child of the famous Coroneus in the land of Phocis, and—nay, scorn me not—rich suitors sought me in marriage. But my beauty proved my bane. For once, while I paced, as is my wont, along the shore with slow steps over the sand’s top, the god of the ocean saw me and grew hot. And when his prayers and coaxing words proved but waste of time, he offered force and pursued. I ran from him, leaving the hard-packed beach, and was quickly worn out, but all to no purpose in the soft sand beyond. Then I cried out for help to gods and men, but my cries reached no mortal ear. But the virgin goddess heard a virgin’s prayer and came to my aid. I was stretching my arms to heaven, when my arms began to darken with light feathers. I strove to cast my mantle from my shoulders, but it was feathers, too, which had already stuck their roots deep into my skin. I tried to beat my bear breasts with my hands, but I found I had now neither breasts nor hands. I would run; and now the sand did not retard my feet as before, but I skimmed lightly along the top of the ground, and soon I floated on the air, soaring high; and so I was given to Minerva to be her blameless comrade. But of what use was that to me, if, after all, Nyctimene, who was changed into a bird because of her vile sins, has been put in my place? Or have you not heard the tale all Lesbos knows too well, how Nyctimene outraged the sanctity of her father’s bed? And, bird though she now is, still, conscious of her guilt, she flees the sight of men and light of day, and tries to hide her shame in darkness, outcast by all from the whole radiant sky.”

Neptune VIII PROTEUS (Πρωτεύς)

Proteus, an early god of the sea, shepherd of Poseidon's seals on Pharos, an island at the mouth of the Nile where he dwells with his wife Psamathe and children.

Euripides: Helene 1–15:

Helen: “These be the Nile’s fair-flowing virgin-streams,
 Who, fed with white snow melting, not with rain
 From heaven, waters Egypt’s lowland fields.
 Lord of this land was Proteus, while he lived,
 Dweller in Pharos’ isle, and Egypt’s king,
 Who of the Maids sea-haunting wedded one,
 Psamathe, widowed wife of Aeacus:
 And to this house she brought forth children twain,
 A son, Theoclymenus—for that honouring
 The Gods his father lived—a noble daughter,
 Named Eido, “mother’s pride,” while yet a babe;
 But, since she grew to bloom of spousal-tide,
 Theonoë they called her, for she knew
 Heaven’s will for things that are and things to be,
 Inheriting from her grandsire Nereus this ...”

Homerus: Odyssea 4,383–424:

(Odysseus, stuck with his companions on Pharos by Proteus, was instructed by the god’s daughter Eidothea—who felt sorry for him—on how he could master her father in order to get his advice on how to escape the island:)

Then verily, stranger, will I tell thee all. There is wont to come hither the unerring old man of the sea, immortal Proteus of Egypt, who knows the depths of every sea, and is the servant of Poseidon. He, they say, is my father that begat me. If thou couldst in any wise lie in wait and catch him, he will tell thee thy way and the measure of thy path, and of thy return, how thou mayest go over the teeming deep. Aye, and he will tell thee, thou fostered of Zeus, if so thou wilt, what evil and what good has been wrought in thy halls, while thou hast been gone on thy long and grievous way (...)

Neptune IX HALIMEDE (Αλιμηδη; “ruling the waves”)

A Nereid.

Hesiodus: Theogonia 240–255:

And of Nereus and rich-haired Doris, daughter of Ocean the perfect river, were born children, (...) and rich-crowned Halimede ...

Apollodorus: Bibliotheca 1,2,7:

To Nereus and Doris were born the Nereids, whose names are ... Halimede ...

Neptune X PSAMATHE (Ψαμαθη)

A Nereid, wife of Proteus whom she begat a son and a daughter.

Hesiodus: Theogonia 240–260:

And of Nereus and rich-haired Doris, daughter of Ocean the perfect river, were born children, (...) and Psamathe of charming figure ...

Euripides: Helene 1–15:

see Neptune VIII PROTEUS.

Neptune XI SAO (Σαω; “rescuer”)

A Nereid.

Hesiodus: Theogonia 240–243:

And of Nereus and rich-haired Doris, daughter of Ocean the perfect river, were born children, (...) Sao ...

Neptune XII LAOMEDEIA (Λαομεδεια; “keeping the people together”)

A Nereid.

Hesiodus: Theogonia 240–257:

And of Nereus and rich-haired Doris, daughter of Ocean the perfect river, were born children, (...) and Laomedea ...

Neptune XIII NESO (Νησω; “mead”)

A Nereid.

Hesiodus: Theogonia 240–261

And of Nereus and rich-haired Doris, daughter of Ocean the perfect river, were born children, (...) Neso ...

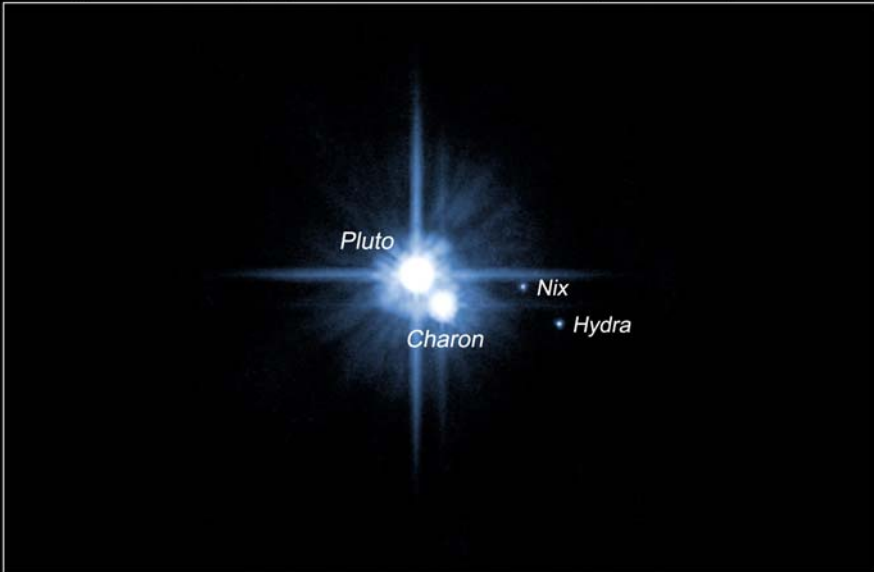
The Satellites of the **Dwarf Planets**

Photograph on opposite page: Pluto, Charon, Nix and Hydra. Hubble Telescope image from February 15, 2006. Copyright NASA, ESA, H. Weaver (JHU/APL), A. Stern (SwRI), and the HST Pluto Companion Search Team

The Satellites of Pluto

Pluto System ▪ February 15, 2006

Hubble Space Telescope ▪ ACS/HRC



NASA, ESA, H. Weaver (JHU/APL), A. Stern (SwRI),
and the HST Pluto Companion Search Team

STScI-PRC06-29

The Satellites of Pluto

Discovering and Naming the Satellites

James W. Christy discovered a satellite of Pluto in June 22, 1978, in photographs taken with the 155-cm (61-inch) astrometric reflector at the US Naval Observatory at Flagstaff, AZ. Christy wanted to name this object Charon, partly because it was a suitable mythological name, and partly because of the initial letters of the name of his wife, Charlene. To the ancient Greeks Charon was the god who transported souls to the underworld.

The existence of the satellite was finally confirmed in early 1985. Charon was then adopted by the IAU as the satellite's official name in 1985 (*Transactions of the IAU*, XIXB, 350; *Sky and Telescope*, 69, 502).

On June 15, 2005, Max Mutchler of the Hubble Space Telescope Pluto Companion Search Team detected two new satellites of Pluto in two images from the Hubble Space Telescope (taken May 15 and 18), which were then confirmed by subsequent as well as archival HST images. They have circular, near-resonant orbits in the same plane as Charon, but are somewhat more distant from Pluto.

The discoverers of these two small inner and outer satellites (provisionally designated S/2005 S 1 and S/2005 P 2, respectively), Alan Stern, Hal Weaver, Max Mutchler, Andrew Steffl, Bill Mereline, John Spencer, Max Buie, Eliot Young and Leslie Young, selected the name Nyx for the former and Hydra for the latter one. The discoverers gave an explanation on their website:

In mythology, Nyx is the goddess of darkness and the night, a very appropriate name for a satellite orbiting Pluto—the god of the underworld. Nyx is also the mother of Charon, which is also appropriate given the giant impact formation paradigm for the formation for Pluto's three satellites, indicating Charon was born of the material from which Nyx is constructed. No planetary satellite bears the name Nyx.

Hydra is the terrifying monster with the body of a serpent that guarded the underworld (Pluto). This is a particularly appropriate name for the outermost moon of the Pluto system, which, so to speak, guards the closer moons and Pluto itself.

Just as Pluto's name honored Percival Lowell (by starting with the letters PL) who motivated the search that led to its discovery, Nyx and Hydra can be thought of as honoring the motivation for our search for new satellites, the New Horizons mission to Pluto (by starting with the letters NH). Additionally, we are cognizant that the first letter of Hydra also honors the Hubble Space Telescope (HST), which is the telescope used to discover the satellites.

Finally, we note that the proposed names for the new satellites follow the convention of using names from Greek mythology for the satellites of planets,

whose names are chosen from Roman mythology (i.e., Pluto is Roman while its satellites Charon, Nyx, and Hydra all are Greek).

These deliberations, fine as they are, were not unanimously accepted at first. Perhaps it was an error not to use Nox (the Roman version of Nyx), since Charon and Hydra were also used by Roman authors, Hydra is already the name of a constellation, and Nyx is the name of a near-Earth asteroid (3908). As a compromise, the discoverers accepted the Spanish translation of the Greek Nyx, and thus the satellite names Nix and Hydra were adopted by the General Assembly of the IAU in Prague in 2006.

Note that all of the satellites of Pluto received Roman numerals as well as asteroid designations:

- (134340) Pluto I Charon
- (134340) Pluto II Nix
- (134340) Pluto III Hydra

Sources of Satellite Names

(134340) Pluto I CHARON (Χαρον)

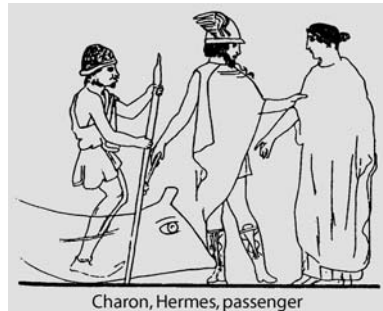
Ferryman of Hades (Pluto); the son of Erebus and Nyx.

Pausanias 10,27,4–28,2:

Polygnotus, a Thasian by birth, son of Aglaophon, painted a picture of Troy's citadel being sacked. The other part of the picture, the one on the left, shows Odysseus, who has descended into what is called Hades to inquire the soul of Teiresias about his safe return home. The objects depicted are as follow. There is water like a river, clearly indeed for Acheron, with reeds growing in it; the forms of the fishes appear so dim that you will take them to be shadows rather than fish. On the river is a boat, with the ferryman at the oars. Polygnotus followed, I think, the poem called the *Minyad*. For in this poem occur lines referring to Theseus and Peirithoüs:

Then the boat on which embark the dead, that the old
Ferryman, Charon, used to steer, they found not within its moorings.

For this reason then Polygnotus too painted Charon as a man well stricken in years. Those on board the boat are not altogether distinguished.



Vergilius: Aeneis 6,295–316:

Hence a road leads to the waters of Tartarean Acheron. Here, thick with mire and of fathomless flood, a whirlpool seethes and belches into Coccythus all its sand. A grim warden Guards these waters and streams, terrible in his squalor—Charon, on whose chin lies a mass of unkempt, hoary hair; his eyes are staring orbs of flame; his squalid garb hangs by a knot from his shoulders. Unaided, he poles the boat, tends the sails, and in his murky craft convoys the dead—now aged, but a god’s old age is hardy and green. Hither rushed all the strong, streaming to the banks; mothers and men and bodies of high-souled heroes, their life now done, boys and unwedded girls, and sons placed on the pyre before their father’s eyes; thick as the leaves of the forest that at autumn’s first frost dropping fall, and thick as the birds that from the seething deep flock shoreward, when the chill of the year drives them overseas and sends them into sunny lands. They stood, pleading to be the first ferried across, and stretched out hands in yearning for the farther shore. But the surely boatman takes now these, now those, while others he thrusts apart, back from the brink.

(134340) Pluto II NIX (Νυξ; “Night”)

Artificial name identified with Nyx, goddess of the night and the mother of Charon (among others).

Hesiodus: Theogonia 123–125:

From Chaos came forth Erebus and black Night; but of Night were born Aether and Day, whom she conceived and bore from union in love with Erebus.

Cicero: De Natura Deorum 3,44:

It is said of Erebus and Nox (Night) that their children also were Amor (love), Dolus (ruse), Metus (fear), Labor (tribulation), Invidentia (jealousy), Fatum (fate), Mors (death), Tenebrae (darkness), Miseria (poverty), Querella (complaint), Gratia (favour), Fraus (deception), Pertinacia (obstinacy), as also the Parcae, the Hesperides and Somnia (dreams).

Euripides: Orestes 175–180:

Chorus: Quen, Majesty of Night,
To travail-burdened mortals giver of sleep,
Float up from Erebus Weith wide wings’ sweep
Come, come on Agamemnon’s mansion light!
Fordone with anguish, whelmed in woeful plight,
We are sinking, sinking deep.



Euripides: Ion 1150–1151:

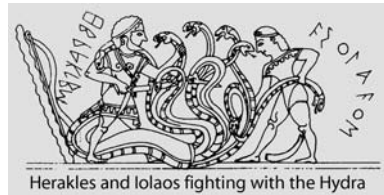
And sable-vestured Nyx (Night) with team of twain upfloated; and the stars accompanied her.

(134340) Pluto III HYDRA (Υδρα)

Nine-headed watersnake that guards the underworld.

Vergilius: Aeneis 6,573–581:

(Beyond the groves of Avernus near Naples) the infernal gates open. Seest thou what sentry sits in the doorway? What shape guards the threshold? The monstrous Hydra, still fiercer, with her fifty black gaping throats, dwells within. Then Tartarus itself yawns sheer down, stretching into the gloom twice as far as is yon sky's upward view to heavenly Olympus. Here the ancient sons of Earth, the Titan's brood, hurled down by the thunderbolt, writhe in the lowest abyss (...)



Herakles and Iolaos fighting with the Hydra

Apollodorus: Bibliotheca 2,5,2:

(The second labour imposed by Eurystheus on Hercules was to kill the hydra in the swamps near Argos.) Now the hydra had a huge body, with nine heads, eight mortal, but the middle one immortal. So mounting a chariot driven by Iolaus, he came to Lerna, and having halted his horses, he discovered the hydra on a hill beside the springs of the Amymone. Where was its den. By pelting it with fiery shafts he forced it to come out, and in the act of doing so he seized and held it fast. But the hydra wound itself about one of his feet and clung to him. Nor could he effect anything by smashing its heads with his club, for as fast as one head was smashed, there grew up two. A huge crab also came to the help of the hydra by biting his foot. So he killed it, and in his turn called for help on Iolaus who, by setting fire to a piece of the neighbouring wood and burning the roots of the heads with the brands, prevented them from sprouting. Having thus got the better of the sprouting heads, he chopped off the immortal head, and buried it, and put a heavy rock on it, beside the road that leads through Lerna to Elaeus. But the body of the hydra he slit up and dipped his arrows in the gall. However, Eurystheus said that this labour should not be reckoned among the ten because he had not got the better of the hydra by himself, but with the help of Iolaus.

Photograph on opposite page: Hubble View of Eris and Dysnomia. Copyright NASA, ESA, and M. Brown (California Institute of Technology)

The Satellite of Eris



The Satellite of Eris

Discovering and Naming the Satellite

A Trans-Neptunian Object (TNO) larger than Pluto was discovered by Michael Brown (Caltech), Chad Trujillo (Gemini Observatory) and David Rabinowitz (Yale University) in CCD photographs taken on October 21, 2003 with the 1.2 m-Schmidt telescope at the Mount Palomar Observatory, and confirmed on January 5, 2005. The provisional designation was 2003 UB 313. Considering the (relatively new) tradition of naming TNOs after creation deities (among others), such as Quaoar and Varuna, Brown's first idea was to name this object Lila, a Hindu description for the periodical creation of the universe as a divine "game" (the Sanskrit meaning of Lila). The name of Brown's (then three-week-old) daughter was also Lilah. On September 10, 2005, however, a satellite of 2003 UB 313 was discovered by Brown and his team and designated S/2005 (2003 UB 313). The ratio of its albedo to that of 2003 UB 313, is 1:8. Inspired by the Centaur asteroids, which are probably extinct comets that orbit the Sun between Jupiter and Neptune, Brown then had the idea of naming 2003 UB 313 and its satellite Xena and Gabrielle, characters from the US and New Zealand TV series *Xena: Warrior Princess* which aired from 1995 to 2001 (Xena and Gabrielle support the people of Centaur when fighting against the evil warrior Dagnine). These names, first announced as code names in *The New York Times*, soon became popular in the media. However, they did not find general acceptance in the scientific community, since there was then a long discussion about the status of 2003 UB 313, which was regarded by many astronomers (and even by Brown himself) as the tenth planet of the solar system due to its large diameter. Another name from classical mythology was therefore demanded.

After a long debate on the nature of solar system bodies, a new classification scheme for such bodies was announced at the General Assembly in Prague on August 24, 2006. The scheme distinguishes between a planet (a body that is massive enough to be rounded by its own gravity and to clear the neighborhood around its orbit, but which is not massive enough to initiate thermonuclear fusion inside it; this corresponds to the eight classical planets), a "dwarf planet" (a rounded body that is not massive enough to have cleared the neighborhood around its orbit; e.g., Ceres, Pluto and 2003 UB 313), and a "small solar system body" (e.g., most of the asteroids, TNOs and comets). The dwarf planets will now be numbered like small solar system bodies. In the case of the dwarf planet 2003 UB 313, the President of IAU Division III (Planetary Systems Nomenclature) agreed that, due to its importance, it should be christened with a name that follows the Greco-Roman tradition of the eight classic planets, and that the naming process—with no further names, such as that of the candidate dwarf planet 2003 EL 61 (an ellipsoidal object with five satellites), anticipated—should be a joint action of the Working Group for Solar System Nomenclature (WGSSN) and the Committee for Small Bodies Nomenclature

(CSBN). Instead of their provisional nicknames Xena and Gabrielle, Michael Brown and his team proposed Eris (meaning discord, strife) for 2003 UB 313, the name of a very early Greek goddess, for 2003 UB 313, and Dysnomia (lawlessness), the name of one of her daughters, for the satellite on September 6, 2006. The name Eris also was regarded as an apt name for a body that has caused so much discord and strife in the astronomical community in forcing the creation of a new scheme for defining what a planet is. On September 13 these names were accepted as the official names by the IAU, as were their new numbers: (136199) Eris and (136199) Eris I.

However there even more to these names than first meets the eye, as reported in 2006 in *Sky and Telescope* (112, 22):

‘We are sad that Xena went away,’ says Brown, noting the nickname’s tie-in to the television series *Xena: Warrior Princess*. So the team held onto her through the name of Eris’s moon. The satellite, now called Dysnomia, is named for Eris’s daughter, the goddess of lawlessness—a tribute to Lucy Lawless, the actress who played Xena.

The moon also follows another tradition. James Christy discovered Pluto’s moon Charon in 1978, and Charon’s first syllable matches the first syllable in Christy’s wife’s name Charlene. ‘We’re going to call the moon ‘Di,’ says Brown whose wife is named Diane.’

Source of the Satellite Name

(136199) Eris I DYSNOMIA (Δυσνομία; “Lawlessness”)

One of the daughters of Eris.

Hesiodus: Theogonia 224–233:

But abhorred Eris (Strife) bare painful Toll and Forgetfulness and Famine and tearful Sorrows, Fightings also, Battles, Murders, Manslaughters, Quarrels, Lying Words, Disputes, Dysnomia (Lawlessness) and Ruin, all of one nature, and Oath who most troubles men upon earth when anyone wilfully swears a false oath.

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Index of Satellites

The first column indicates the number of the moon of the respective planet.

Pages in normal print: discovery, pages in bold print: mythology.

J 15	Adrastea	Адрастия	13, 33
S 36	Aegir	Эгир	61, 84
J 31	Aitne	Этна	18, 43
S 26	Albiorix	Албиорикс	59, 80
J 5	Amalthea	Амалтея	11, 25
J 12	Ananke	Ананка	14, 31
S 49	Anthe	Анфа	62, 89
J 41	Aoede	Аоэда	18, 47
J 43	Arche	Арха	18, 48
U 1	Ariel	Ариель	92, 98
S 15	Atlas	Атлас	59, 74
J 28	Autonoe	Автонон	18, 41
S 37	Bebhionn	Бегбион	61, 85
U 14	Belinda	Белинда	94, 104
S 38	Bergelmir	Бергелмир	61, 85
S 39	Bestla	Бестла	61, 85
U 16	Caliban	Калибан	95, 106
J 17	Callirrhoe	Каллироя	16, 35
J 4	Callisto	Каллисто	12, 23
S 14	Calypso	Калипсо	58, 73
J 11	Carme	Карме	14, 29
J 46	Carpo	Карпо	18, 49
J 21	Chaldene	Калдена	17, 37
P 1	Charon	Карон	128, 129
U 6	Cordelia	Корделия	94, 101
U 9	Cressida	Крессида	93, 102
U 27	Cupid	Купид	95, 110
J 48	Cyllene	Киллена	18, 50
S 35	Daphnis	Дафнид	61, 84
M 2	Deimos	Деймось	4, 5
N 5	Despina	Деспина	114, 119
S 4	Dione	Диона	54, 68
E 1	Dysnomia	Дисномия	135, 135
J 7	Elara	Элара	14, 26
S 2	Enceladus	Энцелад	55, 67
S 11	Epimetheus	Эпимтида	57, 72
S 28	Erriapus	Эрриапус	61, 85

J 25	Erinome	Эринома	17, 40
J 33	Euanthe	Эванфа	18, 44
J 47	Eukelade	Эвкелада	18, 50
J 34	Euporie	Эвпоря	18, 44
J 2	Europa	Эвропа	12, 21
J 32	Eurydome	Эвридома	18, 43
S 40	Farbauti	Фарбаути	61, 86
U 24	Ferdinand	Фердинанд	95, 109
S 42	Fornjot	Форниёт	61, 87
U 22	Francisco	Франчиско	95, 108
N 6	Galatea	Галатея	114, 120
J 3	Ganymede	Ганимед	12, 22
S 51	Greip	Греип	62, 89
N 9	Halimede	Галимеда	115, 122
S 43	Hati	Гати	61, 87
S 12	Helene	Елена	57, 72
J 45	Helike	Гелика	18, 49
J 30	Hermippe	Гермиппа	18, 42
J 6	Himalia	Гималия	14, 25
P 3	Hydra	Гидра	128, 131
S 7	Hyperion	Гиперион	55, 70
S 44	Hyrokkin	Гироккин	61, 87
	Iapetus, see Japetus		
J 1	Io	Ио	12, 20
J 24	Iocaste	Йокасте	17, 39
S 22	Ijiraq	Ийирак	59, 78
J 26	Isonoe	Исоноа	17, 40
S 10	Janus	Янус	57, 71
S 8	Japetus	Иапет	55, 70
S 50	Jarnsaxa	Яарнсакса	62, 89
U 11	Juliet	Юлия	93, 103
J 37	Kale	Кала	18, 45
J 44	Kallichore	Каллихора	18, 49
J 23	Kalyke	Калыке	17, 39
S 45	Kari	Кари	61, 88
S 24	Kiviuq	Кивюк	60, 79
J 49	Kore	Кора	18, 51
N 12	Laomedea	Лаомедия	115, 123
N 7	Larissa	Лариса	114, 121
J 13	Leda	Леда	13, 31
S 46	Loge	Логе	61, 88
J 10	Lysithea	Лисифеа	14, 29
U 26	Mab	Маб	95, 109
U 23	Margaret	Маргарет	95, 108
J 19	Megaclite	Мегаклита	17, 36

S 32	Methone	Метона	60, 83
J 16	Metis	Метида	16, 34
S 1	Mimas	Мимас	55, 66
U 5	Miranda	Миранда	93, 100
J 40	Mneme	Мнема	18, 46
S 25	Mundilfari	Мундилфари	59, 80
N 3	Naiad	Наяда	114, 118
S 31	Narvi	Нарви	60, 82
N 2	Nereid	Нереида	112, 117
N 13	Neso	Несо	115, 123
P 2	Nix	Ночь	129, 130
U 4	Oberon	Оберон	92, 100
U 7	Ophelia	Офелия	94, 101
J 35	Orthosie	Орфосие	18, 44
S 20	Paaliaq	Паалиак	60, 77
S 33	Pallene	Паллена	60, 83
S 18	Pan	Пан	59, 75
S 17	Pandora	Пандора	58, 75
J 8	Pasiphae	Пасифая	14, 27
J 38	Pasithee	Пасифея	18, 45
U 25	Perdita	Пердита	95, 109
M 1	Phobos	Фобос	4, 5
S 9	Phoebe	Феба	56, 71
S 34	Polydeuces	Полидевкь	61, 83
U 12	Portia	Портия	93, 104
J 27	Praxidike	Праксидика	17, 41
S 16	Prometheus	Прометей	58, 74
U 18	Prospero	Просперо	95, 107
N 8	Proteus	Протеи	114, 122
N 10	Psamathe	Псамафа	115, 123
U 15	Puck	Пук	93, 105
S 5	Rhea	Рея	54, 68
U 13	Rosalind	Росалинд	93, 104
N 11	Sao	Сао	115, 123
U 19	Setebos	Сетевос	95, 107
S 29	Siarnaq	Сиарнак	59, 81
J 9	Sinope	Синопа	14, 28
S 27	Skathi	Скати	59, 80
J 36	Sponde	Спонде	18, 45
U 20	Stephano	Стефано	95, 107
S 48	Surtur	Сутур	61, 89
S 23	Suttungr	Суттунгр	59, 78
U 17	Sycorax	Сукоракс	95, 106
S 52	Tarqeq	Таркек	62, 90
S 21	Tarvos	Тарвос	59, 77

J 20	Taygete	Тайгета	17, 36
S 13	Telesto	Телесто	57, 73
S 3	Tethys	Тефия	54, 67
N 4	Thalassa	Фаласса	114, 119
J 14	Thebe	Фйвы	16, 32
J 42	Thelxinoe	Фелксиноа	48, 48
J 18	Themisto	Фемисто	16, 35
S 30	Thrymr	Фримр	59, 82
J 29	Thyone	Фиона	18, 42
S 6	Titan	Титан	54, 69
U 3	Titania	Титания	92, 99
U 21	Trinculo	Тринкуло	95, 108
N 1	Triton	Тритон	112, 116
U 2	Umbriel	Умбриель	92, 99
S 19	Ymir	Имир	59, 76