JOHN C. BARENTINE

UNCHARTED CONSTELLATIONS

ASTERISMS, SINGLE-SOURCE AND REBRANDS

PRAXIS

Springer

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For my grandparents,
Gerald and Verne Anne Danley

Preface

During the writing of this book's companion volume, *The Lost Constellations*, it became clear that the entire project would not fit conveniently into one book of reasonable length. While the original pitch for the project involved only a single book, the editorial staff at Springer-Praxis offered to publish two books covering the project's complete contents, provided a sensible division into two parts existed that would make for acceptable lengths of the resulting books.

My initial reaction was to simply split the assortment of roughly 40 lost constellations into two halves, but on further consideration I found the contents could be naturally divided into two groups based on the answers to a series of questions of the nature of any given figure:

- Was it original?
- Was it 'popular'?
- Was it a constellation?

The last question isn't at all rhetorical: some figures that came and went from historical maps and charts were merely fragments of larger constellations that took on lives of their own. Their status as asterisms ranks them somewhat below the fully-fledged inventions related in *The Lost Constellations*.

While many figures regularly appeared on charts and globes over several centuries, others found only limited circulation. They came and went over much shorter periods, and some only ever appeared on a single map. In the most extreme cases, enterprising cartographers simply poached the creations of the past, appropriating their stars for new constellations that suited their own motives. These historical curiosities enrich our understanding of astronomy as a human enterprise, as much as astronomy is a reflection of both our aspirations and our shortcomings as a species.

The result of this sorting is a set of 16 diverse figures with complex and distinct stories that do not quite fit the mold of *The Lost Constellations*. This volume tells those stories, in many cases for the first time. In addition, two complete families of constellations are described in appendices to the main text: the inventions of the sixteenth century German mathmatician Petrus Apianus and the eighteenth century

English botanist John Hill. Hill's constellations are reproduced here in their entirety for the first time since their original publication in 1754.

It is my hope that readers will find among these pages a garden of celestial delights that will challenge both casual stargazers and serious amateur astronomers alike to find something new and interesting among the familiar figures of the night sky.

Tucson, AZ, USA John C. Barentine
August 2015

Technical Note

Sources

The goal of this book is to be comprehensive without being exhaustive. Original sources of the works referenced herein were preferred in every possible situation. Where the primary works were unavailable, secondary citations were used; I have endeavored to make this distinction clear.

Illustrations

In addition to consulting original written works, I have preferred first printed editions of various charts and atlases as the source of most illustrations in this book, an approach taken in order to show as many interesting depictions of lost constellations as practicable without reproducing every known instance. Depictions from certain seminal works, such as Johannes Hevelius' *Prodromus Astronomiae* (1690) and Johann Elert Bode's *Uranographia* (1801b), are included in every appropriate case; otherwise, the choice of illustrations is made to adequately trace the origin and evolution of constellations in as straightforward as possible a manner.

I have employed a limited amount of manipulation of images from historical atlases, strictly for the purpose of improving the clarity and legibility of those images while never altering the figures therein contained. Mild enhancements, such as those undertaken to increase contrast and reduce the background "noise" of discolored or damaged paper, are not generally noted. Any instances of significant image processing that fundamentally alters the source material, such as digitally joining globe gores to produce a seamless map, have been noted in the text.

Photographs of nonprinted works such as paintings and other illustrations have been reproduced with image density adjustments for clarity only. I have made an effort in every case to try to include in image captions information about the dimensions of the original, the medium, and current location and/or catalog information where obtainable. For works not in the public domain, credit is given to the creator along with usage information such as Creative Commons licenses.

Translations

As a result of preferring original sources, I have often confronted passages in original Latin, German, and French. I render these in English as best as I can, being fluent in none of those languages; wherever possible, I have checked with native speakers or those with extensive formal training in Latin. Sometimes the renderings are imprecise, but I have tried to retain some of the flavor of the original and always the essence. In every instance, I have quoted passages in their original (non-English) languages as footnotes throughout the text such that the reader can decide if my translations are good. Any deficiency in the essence of the translations will be corrected in a future edition. Otherwise, when using others' translations, I have indicated the translator's name and corresponding bibliographic information when known.

Nomenclature

Since by definition the constellations described in this book had fallen into complete disuse by the time of the first International Astronomical Union (IAU) General Assembly, where the canon of modern constellations was decided by the international governing body of professional astronomers, they were never subjected to the process by which the IAU formalized a set of genitive cases and three-letter abbreviations (see Chap. 1). There is also the issue of the names of the constellations themselves; as they passed in and out of fashion and were rendered by authors writing in, variously, Latin, English, French, German, and other languages, a variety of spellings often ensued. I describe here how I settled on a means of standardizing names, cases, and abbreviations across the chapters corresponding to individual constellations.

Constellation Names

The names of constellations adopted by the IAU are a mix of Latin and Greek words; the latter generally derive from the names in circulation at the time Ptolemy wrote the *Almagest* in the second century A.D. Others were Roman inventions, but the names of all constellations in the Ptolemaic canon were Latinized. Some of the first new constellations added since the time of Ptolemy referred to discoveries made by explorers to southern hemisphere destinations and the New World. Latin had no native word for the toucan, for example, so when the native name "tukana" came from the Tupi language of Brazil via Portuguese, it was appropriately Latinized as "Tucana." Petrus Plancius suggested a constellation representing the toucan in 1598, labeling it according to the borrowed Latin. Constellations created in the eighteenth century to celebrate the apparatus of the arts and sciences often required contrived Latin names for concepts unknown to the ancients (e.g., "Globus Aerostaticus" for the Hot Air Balloon and "Machina Electrica" for the Electrical Generator). Sometimes they repurposed ancient words for similar devices such as "Antlia Pneumatica" (later shortened to "Antlia") to describe a mechanical air pump, whereas the word "antlia" referred to a water pump in ancient sources.[1]

I have retained the preference for Latin names in this book in all practical cases; fortunately, many of the extinct constellations here discussed were introduced by their creators with native Latin (or Latinized) names. In isolated cases, constellation names were never Latinized by their creators or involve words that have no obvious Latin equivalent. An example is the Battery of Volta. Since an electrical battery has no conceptual expression in Classical or Medieval Latin, I borrowed the Latin word "pila," meaning a pillar or column, as of stone, to indicate the original sense of a battery as a "voltaic pile." Thus, while I use "Battery of Volta" as the formal name of the constellation, I render its genitive as "Pila Voltae" and its three-letter abbreviation as "PiV."

Genitives

The genitive grammatical case is used to indicate possession, in the sense that a particular star "belongs" to the constellation inside whose boundaries it falls. The widespread use of this convention originated in Johann Bayer's *Uranometria* (1603); Bayer devised a system of cataloging the stars in a particular constellation visible to the unaided eye by the use of Greek letters. According to this scheme, the brightest star in a constellation was labeled "α," the next brightest "β," and so forth through the 24 letters of the Greek alphabet. However, most constellations had more than 24 visible stars; when he ran out of Greek letters in a particular constellation, Bayer ran through the lowercase Roman alphabet starting at "a," among which he omitted the lowercase letters "j" and "v." That brought the total number of available letters to 48. Bayer never exceeded this number in any constellation, but later astronomers sought to extend the series using upper case Roman letters beginning with "A" following "z" and finishing at "Q," inclusive of "J." Within any given constellation, Bayer proceeded from one whole magnitude to the next in half-magnitude intervals; for example, a "third-magnitude star" is any having a visual

[1]For example, Martial, *Epigrammata* 9, 14, 3; C. Suetonius Tranquillus, *Tiberius* 51.

Table 1 Modern constellations whose names consist of two words: nominative case, genitive case, and meaning

Nominative	Genitive	Meaning
Canes Venatici	Canum Venaticorum	The hunting dogs
Canis Major	Canis Majoris	The greater dog
Canis Minor	Canis Minoris	The lesser dog
Coma Berenices	Comae Berenices	Berenice's hair
Corona Australis	Coronae Australis	The southern crown
Corona Borealis	Coronae Borealis	The northern crown
Leo Minor	Leonis Minoris	The lesser lion
Piscis Austrinus	Piscis Austrini	The southern fish
Triangulum Australe	Trianguli Australis	The southern triangle
Ursa Major	Ursae Majoris	The greater bear
Ursa Minor	Ursae Minoris	The lesser bear

magnitude between $+3.5$ and $+2.4$. He further proceeded in an overall north-to-south pattern, then repeating the process for the next-faintest magnitude bin. In other cases, Bayer changed the order of the letters for historical or other considerations.

To complete the designation, Bayer added the classical constellation name in the genitive case; for example, the brightest star in the constellation Canis Major became α Canis Majoris ("alpha of Canis Major"). This convention followed the rules of Latin noun declension, which in some cases required the Latinization of constellation names originally derived from ancient Greek. For instance, Orion became "Orionis" in the genitive case, and the star Betelgeuse, which appeared to Bayer as the brightest in that constellation, became α Orionis.

Among extinct constellations, a variety of names occurs in more than one language. For the purposes of standardizing their genitives as closely as possible to the convention implicitly adopted by the IAU, I constructed genitives based on Latinized forms of the constellation names as described above. Naturally there are some special cases. Modern constellations whose names contain a noun and a modifier, like Ursa Major and Corona Borealis, appear Table 1.

Thus, in the "Name/Modifier" paradigm, both words take the genitive case, so the above examples become Ursae Majoris and Coronae Borealis, respectively. Often the modifier is itself already rendered in the genitive, such as in the case of Caput Medusae. In these situations, the modifier remains unchanged in the genitive, while the name changes case, so "Capitis Medusae" ("*of* the Head *of* Medusa"). There are a few instances of unusual Latin declensions, such as Argo Navis, which becomes Argūs Navis in the genitive. In that singular example I have kept the macron over the "u" in order to specify the genitive as completely as possible.

Abbreviations

At the first IAU General Assembly at Rome in 1922, the Union approved a list of 88 constellations which remain with us today as a modern canon used by professional and amateur astronomers alike. To simplify written references to the constellations, a three-letter abbreviation was devised for each after delegates expressed dislike of a proposed four-letter scheme. The convention determining how a three-letter abbreviation is rendered depends on whether the approved constellation name consists of one or two words. For one-word constellations (e.g., Orion, Taurus, Sagittarius), the word is contracted so as to make each distinct from any other with a similar spelling. So Orion becomes "Ori" and Taurus becomes "Tau," but Sagittarius becomes "Sgr" rather than "Sag," as the latter was reserved for the constellation Sagitta. Therefore, the preferred rendering is the first three letters of the Latinized name, unless some other constellation exists for which those initial three letters are the same. In all cases, the first letter only of the three is capitalized.

If a constellation consists of two words, the format for the three-letter abbreviation is capital-lowercase-capital, where the first capital and lowercase letters refer to the first word in the name (typically Name in the "Name Modifier" paradigm) and the final capital letter refers to the second word. So Corona Borealis becomes "CrB" and Piscis Austrinus becomes "PsA." However, there are many irregularities. In some cases, the abbreviation is formulated capital-capital-lowercase, as "CVn" for Canes Venatici and "UMa" for Ursa Major. Then there is the completely inexplicable "Com" for Coma Berenices, ignoring entirely the second word. Rather than explicitly naming a formula for making these determinations, the IAU simply published the abbreviations as a list.

I have attempted to impose a set of rules in creating abbreviations for extinct constellations:

- For three-letter abbreviations of constellations containing two words, I followed the predominant IAU convention of capital-lowercase-capital. When "Major" or "Minor" is the modifier, I follow the form capital-capital-lowercase *except* if the result is identical to an existing IAU abbreviation. So, e.g., Cancer Minor cannot be shortened as "CMi" because Canis Minor already holds that abbreviation. So, Cancer Minor becomes CnM.
- In a few situations, there are totally unique combinations such as "Cerberus et Ramus Pomifer." This I rendered as "CeR" ("Cerberus et Ramus").
- For names consisting of three words, each word receives one capital letter. So, e.g., Gladii Electorales Saxonici becomes GES.
- There are two names consisting of three words where the last word is a modifier, and the names differ *only* by that modifier: Telescopium Herschelii Major and Telescopium Herschelii Minor. Since there is no proper way to reduce these names to three-letter abbreviations without losing essential elements, I opted for four letters: THMa and THMi.

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Celestial Odds and Ends

Chapter 1
What Is a Constellation?

> [A]ncient customs are difficult to overcome, and it is very probable, that, except the recently-named groups, which we may now suppress, the venerable constellations will always reign.
>
> Camille Flammarion, *Astronomie Populaire* (1880)

The Construction of Our Galaxy

From a dark location on Earth, far from sources of artificial light pollution, a few thousand stars are sufficiently bright to be seen by the unaided human eye. One popular misconception about the stars is that brightness indicates distance, fainter stars being located further away from Earth than the bright ones; were it the case that all stars had identical *intrinsic* brightnesses, this would be true. But by the twentieth century, astronomers realized that the luminosities of stars spanned an enormous range of values, from those many thousands of times intrinsically brighter than the Sun to those just a fraction of a percent of our own star's luminosity. The brightness of stars, then, does not tell us much about the immediate volume of space we inhabit. That some stars are brighter and others are fainter is also only part of the story by which certain ones come to form recognizable patterns to humans.

The main influence on the distribution of stars in the night sky has to do with our location in (and the structure of) the Milky Way galaxy. Our home galaxy is a common type known a "disk spiral" in which a set of spiral arms, regions dense with stars and the materials from which they form, unwind from the center to the edge. Since we live inside the Milky Way's disk, our understanding of the geometry of the Galaxy comes from the structures we can infer from our vantage point, supplemented by studies of other galaxies seen from the outside that we think resemble the Milky Way. Combining information from both sources, we can make an educated guess as to both the shape of our galaxy and the location of our Solar System within it.

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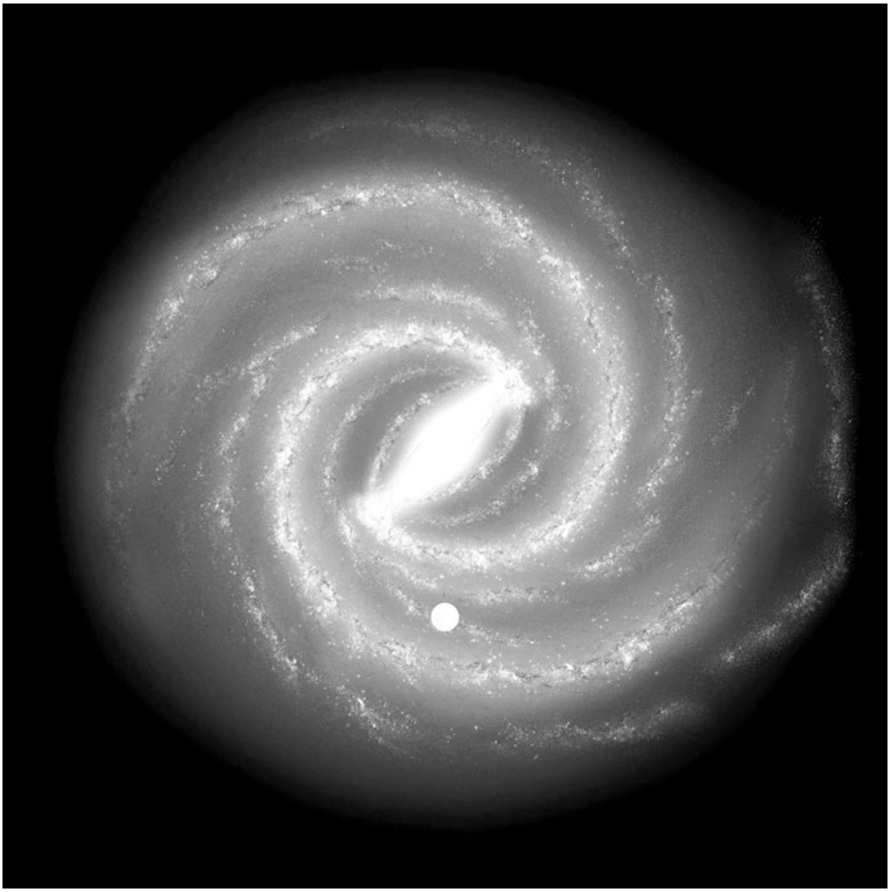

Fig. 1.1 An artist's rendering of the Milky Way as it might appear viewed face-on from several hundred thousand light years above the midplane. The *solid white circle* indicates the location of the Sun. Illustration by R. Hurt (NASA/JPL-Caltech)

An artist's conception of the Milky Way is shown in Fig. 1.1, illustrating what a viewer situated high above the plane of the galaxy might see looking down at it. The Sun, whose position is marked by a white circle, makes a leisurely orbit around the Galactic center once every 225–250 million years. Our motion through the Galaxy ensures that the Earth's night sky is never static, and that the stars of tonight's sky differ from those of the distant past and future.

Humanity's first view of the Milky Way as a single stellar system emerged in the eighteenth century. While the Galaxy has been known since time immemorial, an understanding of its composition awaited the invention of the telescope. In 1610, Galileo Galilei turned one to the Milky Way for the first time, resolving its luminous clouds into innumerable faint stars. A century later, philosophers and scientists began to devise ideas about what the Galaxy physically represents. The English

Fig. 1.2 William Herschel's model of the Milky Way based on his star counts. The model is essentially a longitudinal slice through the Galaxy, reflecting the Solar System's position within its Disk. Figure 4 from "On the Construction of the Heavens," *Philosophical Transactions of the Royal Society of London*, Vol. 75, pp. 213–266 (1785)

astronomer Thomas Wright published *An original theory or new hypothesis of the Universe* in 1750, in which he posited that the Milky Way was a large, rotating body composed of individual stars held together by gravity. He deduced it was a scaled-up version of the Solar System, by then describable with relatively simple physics under Isaac Newton's universal theory of gravitation. In 1755, the German philosopher Immanuel Kant elaborated on Wright's hypothesis, suggesting that the Milky Way might have begun as a spinning cloud of gas that somehow condensed into stars. He further speculated that other similar systems might exist and that the faint and featureless nebulae seen in contemporary telescopes could be such "island universes" unto themselves.

Based on his careful telescopic counts of stars toward various directions in the night sky, the Anglo-German astronomer William Herschel made probably the first attempt at a structural model of the Milky Way (Fig. 1.2), correctly concluding that the Solar System was embedded inside it. From this vantage point, Herschel wrote,

> the heavens will not only be richly scattered over with brilliant constellations, but a shining zone or milky way will be perceived to surround the whole sphere of the heavens, owing to the combined light of those stars which are too small, that is, too remote to be seen. Our observer's sight will be so confined, that he will imagine this single collection of stars, of which he does not even perceive the thousandth part, to be the whole contents of the heavens.

Historical interest in the makeup of the Galaxy here is not about appreciating Galactic structure as a subject in its own right; rather, it is in understanding how the bright stars are scattered about our night skies. The bright stars that mark the familiar constellations tend to be remarkably close to Earth, and many are intrinsically faint. Given the rapid drop-off of observed brightness with distance, it is clear that most of the stars visible to the naked eye are within a relatively short distance of Earth; in order to see such low-luminosity stars, they cannot be very far away from us.

We do not live in a part of the Galaxy particularly close to where stars are actively forming; this point is important because such clustered environments are the only places where the distribution of stars in small volumes of space is relatively uniform. Once stars leave their natal clusters, they drift away in random directions until their orbits around the Galactic center are no longer distinguishable from the myriad others. For all intents and purposes, the bright stars in Earth's night skies are distributed (semi-)randomly, and do not lend themselves to any *apparent* positional hierarchy imposed by the laws of nature. The constellations, therefore, are a distinctly human invention dictated by culture and imagination rather than being the result of any physical process. How and why we ended up with a sky full of mythical heroes and fantastical beasts says much more about the human condition than it tells us anything useful about how the heavens are constructed.

History, Mythology, and Pattern Recognition

The tendency of the human brain to detect regular patterns has served our species very well in the realms of science and technology; the assembly of taxonomies is often the first instinct of scientists when confronted with new and unfamiliar data sets. We look for similarities and bin them together in a form of intellectual stamp collecting (hopefully) before speculating on the underlying natural laws and principles that make for different categories of phenomena. This approach exploits the superior capacity of the human brain for pattern recognition, of sensing a signal buried within the noise and applying that capacity to problem solving. Recognizing patterns in the locations of certain stars in the sky, and the seasons in which they rose and set at particular times of night, became indispensable to early humans dependent on the cyclical population dynamics of various plants and animals. Understanding calendric cues in both the day and night sky was crucial to both the survival of our nomadic ancestors and the transition to settled cities after the invention of agriculture some 12,000 years ago.

Constellations are among the oldest human cultural inventions, certainly predating writing and, in all likelihood, civilization itself. The presumably oldest figures still in existence, such as the Hunter and the Bull (Fig. 1.3), refer to a time in human history before the emergence of settled agricultural communities. It is probably no coincidence that Orion and Taurus reflect themes in the oldest extant works of art: the human form and game animals. Furthermore, it is likely that well-developed oral traditions about these figures long predate the development of written proto-language in the early Neolithic period, perhaps as long ago as the seventh millennium BC. Around 10,000 years ago humanity began a journey in folklore associated with a religious tradition, developed it for practical purposes and ultimately refined it in the empirical interest of science.

The earliest surviving written record of constellations comes from Mesopotamia and is found in a text called "Prayer to the Gods of the Night" (Cooley 2011), dating from about 1700 BC, which references the Arrow (the star Sirius), the Yoke Star (the star Arcturus), the "Stars" (the Pleiades star cluster), the True Shepherd of Anu (Orion), the Dragon (possibly the constellation Hydra), the Wagon (the "Dipper" stars of Ursa Major), the Goat Star (Vega) and the Bison (the composite figure depicted in the constellations Ophiuchus and Serpens). A more detailed account, consisting of lists and observations of nearly all the Mesopotamian constellations, was carefully recorded in cuneiform script in the so-called "MUL.APIN" tablets (Watson and Horowitz 2011) whose oldest dated version was written in the eighth

Fig. 1.3 Paleolithic depiction of an aurochs (*Bos primigenius*) on a cave wall near Lascaux, France, dating to *c.* 15,000 BC. The figure is thought by some (Edge 1997; Rappenglück 2004) to represent the constellation Taurus, with a *series of dots* on the bull's face standing for the Hyades star cluster. The *six dots* above the bull may refer to the Pleiades star cluster

century BC but is based on observations from before 1000 BC. The figures of the classical zodiac were established in the Old Babylonian period of the Near East and cast in their final form during the Neo-Babylonian era around the sixth century BC.

The folklore that originated in the earliest societies of the Fertile Crescent was transmitted widely across the region. Around the time of the rise of classical Greek culture, the author of the Biblical Book of Job referred[1] to several asterisms, including Ursa Major (the Great Bear), Orion (the Hunter), and the Pleiades. Expanding on earlier work by Hunger and Pingree (1999) on the MUL.APIN tablets, Schaefer (2006) recently concluded, somewhat controversially, that "most of the Mesopotamian constellations and observational data were made from near a latitude of 33–36° between 1300 and 1000 BC, by people we would call Assyrians." Adding additional constraints in the fourth century BC works of the Greek astronomer Eudoxus of Cnidus (408–355 BC), he further narrowed the time and place of the classical constellations' origin to 1130 BC and 36° north latitude. This work suggests that the figures in the Western tradition that occupy the night skies of the northern hemisphere were essentially in place as we now know them around 3000 years ago and originated in or near the northern half of Mesopotamia.

[1] Job 9:9, 38:31–32.