Annals of Science
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tasc20

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Version of record first published: 23 Aug 2006.

To cite this article: E. Dekker (1987): Early explorations of the southern celestial sky, Annals of Science, 44:5, 439-470

To link to this article: http://dx.doi.org/10.1080/00033798700200301

ANNALS OF SCIENCE, 44 (1987), 439–470

Early Explorations of the Southern Celestial Sky

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Received 28 August 1986

Summary

In this paper the astronomical explorations of the southern celestial sky by Dutch navigators at the end of the sixteenth century are investigated. It is shown that the main motivation for this scientific enterprise stemmed from Dutch cartographic tradition and interests, represented first and foremost by Petrus Plancius and the competing globemakers Hondius and Blaeu. It is shown, too, that at the time actually two surveys were carried out. We have investigated the results of the two surveys by analysing the data presented on celestial globes by Hondius and Blaeu, and in the star catalogue published by De Houtman in 1603. It appears that only after the first survey was it recognized that the stars of the well-known Southern Cross constellation could be matched with stars already recorded by Ptolemy.

Contents

1. Introduction

The discovery of the New World in the fifteenth and sixteenth centuries by European navigators and traders contributed in many different ways to the extension of the then existing stock of knowledge. Much has been written on the growth of geographical knowledge and the cartographic achievements that went along with it. The importance of these geographic explorations for biology, namely through the fascinating descriptions of the flora and fauna of the southern continents is also well known. However, when we come to the question of what impact the voyages of discovery had in the field of astronomy, a radically different situation is encountered. The discovery and description of the southern sky, not visible from European latitudes, form the only direct contribution to astronomy achieved through voyages of exploration in the age of reconnaissance. With it a long-existing gap in the knowledge of the starry sky was filled, but this neither changed nor influenced the contemporary conception of the world.

What then is the relevance of the present study? First and foremost we have investigated the discovery of the southern sky within the framework in which it belongs, namely that of celestial cartography. Throughout the ages much astronomical research has been devoted to the quantitative description of the positions of the stars in space, which resulted in a good many star catalogues. One of the oldest of these is the star catalogue that was included by Ptolemy in his Almagest. For a very long time this catalogue showed the extent of our knowledge of the starry sky. The discovery of the southern sky was the first event to change this situation. As new non-Ptolemaic stars were recorded the 'invention' of new, non-Ptolemaic constellations was called for.

From the point of view of celestial cartography, we shall chiefly be concerned with the Dutch contribution to it. Certainly, Italian, Portuguese, and English navigators and traders preceded the Dutch in the ocean-going trade and therefore it can be reasonably supposed that the former must have possessed at least some knowledge of the southern celestial sky. How extensive this knowledge was is not known, however, since very little of it has been made public. This holds also for the star catalogue of Amerigo Vespucci, which, upon the return of his second voyage, was handed over to King Manuel I of Portugal.[1]

Consequently, the Dutch started their ocean-going trade at the end of the sixteenth century with only a vague knowledge of the southern celestial sky. Even the location of the Southern Cross was not known. The drastic increase in knowledge that was brought about by the Dutch explorations is well illustrated by the fact that within a decade after the departure of their first voyage to the East Indies in 1595, five celestial globes had been published, showing the newly recorded southern stars in relation to the already known part of the starry sky, nicely grouped together into twelve new constellations around the South Pole. The first catalogue of the stars around the South Pole had also been published by this time.

In the present paper we intend to give a clear outline of the particulars of this considerable achievement and of the personalities involved in the explorations. In doing so we shall draw attention to the importance of celestial globes as sources for the history of celestial cartography. By careful analysis of these sources new facts can be brought to light and a number of misunderstandings (such as the alleged plagiarism of Frederick de Houtman, the author of the star catalogue referred to above) may be cleared up.

We end our study with a few remarks and questions regarding the historical perspective in which the Dutch explorations should be placed. Our conclusion is that these first explorations served cartographic rather than the navigational interests. This does perhaps answer the intriguing question as to why it was the Dutch and not their predecessors in deep-sea travel who provided the first complete description of the southern celestial sky.

[1] E. B. Knobel, 'On Frederick de Houtman's catalogue of the southern stars', *Monthly Notices of the Royal Astronomical Society*, 77 (1917), 421–32. Particulars are also mentioned in Deborah J. Warner, *The sky explored: celestial cartography 1500–1800* (New York, Amsterdam, 1979), pp. 58, 173, 225.

2. The 'Eerste Schipvaart'

In 1595, on April the second, the first expedition of the Dutch to the East Indies departed from Amsterdam. This voyage, known by historians as the 'Eerste Schipvaart' (First Voyage), was the beginning of the establishment of Dutch power in the Indonesian archipelago that has lasted until after World War II.[2]

The development of foreign trade in the Low Countries at the turn of the sixteenth century, of which the 'Eerste Schipvaart' formed the starting point, went hand in hand with the activities of a number of distinguished cartographers. Having fled northwards from religious persecution, men like Plancius, Van Langren and Hondius provided the basis for a thriving mapmaking industry, in which natives from the northern part of the country, like Blaeu, soon started to participate.[3] Almost from the very beginning the Dutch cartographic industry was strongly influenced by the competitive element. Products like maps and globes were often protected by patents. This certainly stimulated the scientific interests of the cartographers, for the incorporation of new data was often the only way to circumvent an already existing patent. Besides, scientific results could effectively be used to promote new products.

Of course, its economic importance (for example, to be able to meet the navigational demands of the ocean-going trade) formed the primary stimulus for these cartographic activities. The 'Eerste Schipvaart', financed by a number of Amsterdam merchants, was the first opportunity for Dutch cartographers to explore the southern hemisphere scientifically. They did not fail to utilize it. This first Dutch expedition was not undertaken precipitately. Prior to its departure a reconnaissance had been made by Cornelis de Houtman (who would act later as its principal commercial leader). Together with his brother Frederick he spent more than a year in Lisbon to spy on the Portuguese. From a still extant manuscript in which the results of this reconnaissance are summarized, we conclude that the navigational know-how available at the departure of the 'Eerste Schipvaart' still did not exceed the common knowledge of those days.[4] No secret information appears to have been obtained. There was, therefore, sufficient motive indeed to utilize the expedition also to solve one or two of the most urgent navigational problems related to the ocean-going trade.

The scientific programme carried out during the 'Eerste Schipvaart' appears to have had two main purposes. The first one was to measure the magnetic deviation of the direction of the compass needle, a project directly related to the most fashionable navigational problem of those days, namely the determination of the longitude at sea. The other was to chart the stars around the south pole, invisible from European latitudes. All available evidence indicates that the results of these scientific explorations were to be handed over to the theologian and cartographer Petrus Plancius.[5] This is not surprising, for Plancius was entitled to claim as his intellectual property all data gathered during the voyage, a right that had been ensured on his behalf by the

[2] Sources relevant for the backgrounds of this expedition, provided with extensive notes, were published as numbers 7, 25 and 32 in the series *Werken uitgegeven door de Linschoten-Vereeniging*, G. P. Rouffaer and J. W. IJzerman, editors, *De eerste schipvaart der Nederlanders naar Oost-Indië onder Cornelis de Houtman, 1595–1597*, 3 vols ('s-Gravenhage, 1915–1929).

[3] J. G. C. A. Briels, *De Zuidnederlandse immigratie, 1572–1630* (Bussum, 1978).

[4] Cornelis de Houtman, 'Corte verklaringe per Cornelis de Houtman van de landen genaemt Oost-Indien ofte conquisten van Portugal' [1594–1595], manuscript in the Rijksmuseum Nederlands Scheepvaart Museum, Amsterdam, registered as Cat A IV-2, 243a.

[5] A biography of Plancius was published by J. Keuning, *Petrus Plancius: theoloog en geograaf, 1522–1622* (Amsterdam, 1946).

Amsterdam merchants from the States General prior to the departure of the voyage.[6] It explains why after the return of the expedition in 1597 every participant was charged to hand over all his scientific and navigational data.[7] This order was not met with enthusiasm, which might have motivated the Amsterdam merchants to request from then on a promise under oath from all hands and participants to secrecy of all information—including that of the 'heavenly skies'—collected during future voyages.[8] Finally, Plancius' claim might explain, as we shall discuss later, why soon after the return of the 'Eerste Schipvaart' a second survey of the southern celestial sky was undertaken.

Most of the data received by Plancius have, unfortunately, been lost. Only two manuscripts, both related to the variation of the compass needle, survive. The first one is an actual list of observations made by Frederick de Houtman.[9] The second is a 'Memorie' (a kind of progress report, presumably for the benefit of the Amsterdam merchants) about the problem of finding the longitude at sea, in which the relevant observations made during the voyage have been summarized.[10]

Apart from these sources several public accounts of the scientific discoveries exist, all of which came into being through the kind offices of Plancius, who was apparently too busy to publish. The data on the variation of the compass needle were put at the disposal of Simon Stevin for publication in his 'Havenvinding'.[11] A descriptive account of the data on the stars around the south pole was given to Merula, the librarian of the Leiden university who included it in his 'Cosmographiae'.[12] It is here that the publication of a catalogue of the stars (with the precise location in longitude and latitude) by Plancius himself is announced.[13] Since such a catalogue was never published, we do not know whether Plancius ever completed the work. What he did do was to make the relevant data available to Hondius, who depicted them on his celestial globes from 1598 onwards.[14] We note here in passing that this cannot be taken as evidence that a catalogue (i.e. a list of data in absolute coordinates) also existed. For the production of a globe, in principle only the measured relative distances between the stars are needed; for the production of a catalogue such data first needs to be reduced and processed, which is a rather tedious and time consuming undertaking.

The initiatory role of Plancius is evident from the legend on a globe published by Hondius in 1598:

> The stars around the south pole could be observed neither by Hipparchus, nor by Ptolemy or by any of the ancients. But these have at my request and instigation

[6] Keuning (footnote 5), 130, and Resolutions of the Staten van Holland, inv. nr. 28, p. 347, 354–55, Algemeen Rijksarchief, 3e afdeling, 's-Gravenhage [General State Archives, The Hague]. The patent requested refers to knowledge of the longitude and latitude.

[7] C. P. Burger, *Amsterdamsche rekenmeesters en zeevaartkundigen in de zestiende eeuw* (Amsterdam, 1908), p. 50.

[8] Rouffaer and IJzerman (footnote 2), III, xxi.

[9] Ibid., III, 426.

[10] Ibid., III, 411.

[11] Simon Stevin, 'De havenvinding', in *The principal works of Simon Stevin*, 6 vols (Amsterdam, 1955–1966), III, 419–75 (pp. 430–33).

[12] Paullus Merula, *Cosmographiae generalis libri tres, item Geographiae particularis libri quattuor* (Lugdunum Batavorum [= Leyden], 1605).

[13] Ibid., 105.

[14] A description of a copy of this celestial globe has been given by Hinze, 'Drei Globen des 16. Jahrhunderts', in *Bericht des Naturwissenschaftlichen Vereins zu Zerbst, 1927–1932* (Zerbst, 1933), pp. 10–20. Also described by Warner (footnote 1), 203. Note that the first five lines cited by Warner deviate from the description given by Hinze, and refer to the globe of Hondius, published in 1600, also described by Hinze.

> been observed with the greatest and most accurate diligence by the well-experienced navigator Petrus son of Theodorus [Pieter Dircksz], of blessed memory, and by other lovers of astronomy, during that memorable voyage to the East Indies [financed] by the Amsterdam merchants, for which they departed on April 2nd, 1595, and from which they returned on August 6th, 1597. The star in Eridanus is of the first magnitude and is usually named Acarnar. And they through often repeated observations have found it to be at 9 degrees and 45 minutes and at 59 degrees and 30 minutes latitude. We have set the other stars in their positions for the year 1600; for the future 1 degree and 25 minutes per century must be added. Engraved and published by Jodocus Hondius.[15]

The other legend on the same globe is a dedication by Plancius to the States General. Thus Plancius can be identified as the author of the globe and as the composer of the text cited above.

The very detailed content of this legend contrasts strongly with the rather short (and consequently incomplete) versions on the later Hondius globes of 1600 and 1601.[16] This has led to the belief that all credit for the discovery of the southern sky should be attributed to one man, namely Pieter Dircksz Keyser. But the legend cited above leaves little doubt that others have also contributed to the astronomical part of the scientific programme. This does not seem unlikely. The journey was a very hazardous undertaking indeed. Of the 249 participants only about 90 survived. Surely it would not have been wise to let the success of the scientific explorations depend on one man alone.

Who, then, have the other lovers of astronomy been? We think we can make a good guess. Educated navigators able to handle mathematical instruments were probably few in number at the end of the sixteenth century. On a voyage like the 'Eerste Schipvaart' such talent could hardly be wasted. This implies that all men with some mathematical ability received instructions with regard to both parts of the scientific programme. This point of view is confirmed by the limited evidence available. Of the four men explicitly credited for the measurements of the variation of the compass needle by Plancius in his 'Memorie' on the finding of the longitude, namely Pieter Dircksz Keyser, Vechter Willemsz, Frederick de Houtman and Pieter Stockmans, at least three seem also to have been connected with the astronomical part of the programme.[17] Keyser and Willemsz received instruction in astronomy from Plancius prior to the journey.[18] The involvement of Frederick de Houtman stems from a claim

[15] The Latin text according to Hinze (footnote 14), 18–9, reads as follows: 'Viciniores Polo Antarctico stellas nec Hipparchus, nec Ptolomeus, nec ullus veterum observare potuit; at eas summa ac accuratissima diligentia observarunt, meo rogatu et instinctu, peritissimus nauclerus Petrus Theodori, piae memoriae, et alii Matheseos studiosi: itque in memorabili illa Indica Amsterodamensium navigatione ad quam postridie Calendas Aprilis an. 1595 solverunt et ex qua redierunt 6. Idus Augusti an. 1597. Quae in Eridano primae est magnitudinis vulgo Acarnar vocatur; eam seapius iterata dimensione in 9. gradu et 45. scrup. invenerunt; et eius latitudinem esse 59 graduum et 30 scrupul. Caeteras stellas suis locis reposuimus ad annum 1600. pro sequenti seculo addenda erunt unus gradus et 25 scrupula. Jodocus Hondius caelavit et divulgat.

[16] Peter van der Krogt, *Old globes in The Netherlands: a catalogue of terrestrial and celestial globes made prior to 1850 and preserved in Dutch collections* (Utrecht, 1984), pp. 148–58. Here a complete description is given of the globes published by Hondius in 1600 and 1615. The latter is a new edition of the globe published in 1601, with which it is identical.

[17] Rouffaer and IJzerman (footnote 2), III, 416.

[18] Merula (footnote 12), 103.

in the introduction of the star catalogue which he published in 1603 on the return from a second journey.[19] We shall discuss this in the next section.

Since doubts have been raised (albeit for wrong reasons) about the reliability of Frederick de Houtman's statements, we note here that, so far, no inconsistency can be found between his claim and the facts presented. On the contrary, he has proved himself an able observer of the variation of the compass needle. Moreover, as a volunteer he had more opportunities to make observations than men like Keyser and Willemsz, who both had to look first after their duties as first mate.[20] We therefore must consider Frederick de Houtman as a serious candidate among those 'lovers of astronomy' who, next to Keyser, contributed to the astronomical observations carried out during the first voyage.

In order to complete the picture of the men involved in the scientific enterprise we have investigated the possibility of some sort of co-operation between them. The very fact that, for instance, Frederick de Houtman and Pieter Dircksz Keyser sailed on the same ship would suggest that. Unfortunately, the journals published upon the return of the 'Eerste Schipvaart' provide very little information, except that it is questionable that Keyser and De Houtman would have worked together. They were actually on opposite sides in serious disputes which took place throughout the journey.

Much of the irritation seems to have been caused by Frederick de Houtman's brother, Cornelis, the most powerful man during the voyage. One of the disputes resulted from a quarrel between him and a merchant from Embden, named Van Beuningen, who sailed on the ship on which Keyser was first mate.[21] It is unlikely that this was a coincidence. Keyser originated from a family that since 1570 had served the trading interests of the Van Beuningens.[22] Although no evidence exists that Keyser was under an obligation to Van Beuningen, there is ample evidence that he was victimized in the struggle for power between Van Beuningen and Cornelis de Houtman. The immediate cause for the dispute had been the sealed instructions by the Amsterdam merchants (most likely given out on the advice of Plancius) for the appointment of a new captain (Keyser) in case of the death of the acting captain. This indeed happened, and the ensuing dispute ended in a defeat for Van Beuningen; someone other than Keyser was appointed captain.

Another consequence of this quarrel was a reallocation of the men between the ships. From the measures taken it follows that the position of Frederick de Houtman was closely related to those of his brother *and* of Keyser.[23] Since the actions of the participants in the expedition were guided more by distrust than by co-operation, we are inclined to interpret the reallocation of Frederick de Houtman as being a means to spy upon the party that opposed his brother.

During the rest of the voyage the party of Cornelis de Houtman had the upper hand, and Pieter Dircksz Keyser remained first mate until he died in September 1596, a few months after the arrival in the East Indies. He did not, as Merula states, play a leading part during the expedition. Nor would that have been in keeping with his general conduct, since he showed himself as a rather modest man in the quarrels referred to

[19] Frederick de Houtman, *Spraeck ende woord-boeck, inde Maleysche ende Madagaskarsche talen*...(Amsterdam, 1603).

[20] Rouffaer and IJzerman (footnote 2) II, xxiv, xxix and III, lxix.

[21] A full account of this quarrel is given in Rouffaer and IJzerman (footnote 2), III, 211–84.

[22] Ibid., III, lxiv.

[23] Ibid., III, 216, 233–6.

above.[24] Although all this does not exclude co-operation between Keyser and Frederick de Houtman in their observational activities, it does not make such co-operation self-evident, or even likely.

Little information is available about the men that were actually engaged in carrying out the scientific programme, and even less is known about the ways in which this was done. What instruments were used? What might have been the 'priceless instrument' that according to Merula was received by Keyser from Plancius?[25] Was it an astrolabe or a back-staff, or was it the instrument described by Plancius for the conversion of co-ordinate systems—now known as an astrolabium catholicum?[26] Without new source material becoming available, these questions cannot be answered.

Before turning towards the observational results that were actually obtained during the first voyage, it is useful to discuss first a second survey, which was carried out by Frederick de Houtman during his second journey.

3. The second voyage

Usually the 'Tweede Schipvaart' (Second Voyage) is understood by historians to be the second expedition to the East Indies organized by the Amsterdam merchants. However, before this second convoy started, another had already set sail in March 1598.[27] With it, a second chapter in the history of the mapping of the southern sky by Dutch navigators begins.

Determined to get his share, and excited by the pepper frenzy that broke out in Holland after the return of the 'Eerste Schipvaart', Balthasar de Moucheron, a merchant from Middelburg, succeeded in contracting a number of the participants of the first voyage to a second trip. Among them were both Cornelis and Frederick de Houtman and Pieter Stockmans. This change of employers is sometimes explained by historians as the result of bad blood between Cornelis and the Amsterdam merchants.[28] Whatever the motives may have been, of interest to us is that the astronomical survey performed during this second journey was not carried out under the auspices of De Moucheron (whose interests were purely commercial), but undertaken as a private enterprise by Frederick de Houtman.

The circumstances under which he had to execute it were far from ideal, for after the arrival of the convoy in Sumatra an unfortunate skirmish broke out (September 1599) between the Dutch traders and the Sultan of Atjeh.[29] Cornelis de Houtman and many others were killed, and Frederick de Houtman found himself among the prisoners. Pieter Stockmans and some others succeeded in escaping, and returned home to report on this catastrophe. Only in August 1601 (thus after almost two years) was Frederick de Houtman released to return home (in July 1602).[30] With him he carried a series of new observations of the stars around the antarctic pole.

[24] Ibid., III, 230, 237.

[25] Merula (footnote 12), 102.

[26] Rouffaer and IJzerman (footnote 2), III, 413, 423.

[27] W. S. Unger, *De oudste reizen van de Zeeuwen naar Oost-Indië, 1598–1604* ('s-Gravenhage, 1948) in the series Werken uitgegeven door de Linschoten-Vereeniging, nr. 51. The most important journals are from John Davis, the pilot of the expedition, and Frederick de Houtman, who during this voyage acted as a captain.

[28] J. C. Mollema, *De eerste schipvaart der Hollanders naar Oost-Indië, 1595–1597*...('s-Gravenhage, 1935), p. 47.

[29] Unger (footnote 27), 50, 75.

[30] Ibid., 109 and Mollema (footnote 28), 50.

From his journal it appears that during the last eight months of his captivity in particular he suffered serious hardship. For the rest of it he was allowed to move about freely. Therefore it was presumably during that first period that the new observations were obtained.

Contrary to Plancius, Frederick de Houtman did succeed in publishing his data in the form of a catalogue, which appeared in 1603 as an appendix to his *Spraeck ende woord-boeck*, a dictionary of the Malayan language. He also succeeded in having his catalogue patented for a period of eight years. Appreciation for this work by the States General was expressed by an award of '100 Carolus guldens'.[31] Since the text of the introduction to the catalogue has been misinterpreted repeatedly, we shall give here the English translation in full.

> Finally here [is] also added the declination of several fixed stars which during the first voyage I have observed around the south pole; and during the second, in the island of Sumatra, improved upon with greater diligence, and increased in number such as these (more than 300) can be seen on the celestial globes, which (after the observations of the widely famous Tycho Brahe) have been published by Willem Jansen of Alkmaar [Blaeu] who lives in Amsterdam. Which stars serve all sailors, who navigate south of the equinoctial line and are of interest to all lovers of astronomy or the mathematical arts. This, Gentlemen, is what has motivated me to undertake this work. And that it may meet with success and be protected against evil tongues and envious persons I have published it under Your Honours' gracious protection.[32]

The claims put forward by De Houtman have been contradicted by Knobel, in his study of the discovery of the southern stars. He concluded 'that the whole catalogue and the formation of the new twelve constellations must be attributed to Pieter Dircksz Keyser, and not in any way to Frederick de Houtman'.[33] If this conclusion were correct, it would imply that at the turn of the sixteenth century one and only one survey of the southern celestial sky was carried out, for Keyser died during the first voyage.

In the next section, our analysis of the available globes provides ample evidence to the contrary: two surveys were made on consecutive voyages. What is more, we have established that the second survey was definitely more extensive than the first.[34] Combining this with the involvement of Frederick de Houtman with the scientific programme during the first voyage, there remains no reason to doubt the reliability of the statements made by him in the introduction to his catalogue. If credit is to be attributed, Keyser must certainly be mentioned as having played the major part in obtaining the observations during the first survey. Frederick de Houtman, however, deserves the credit for the second survey and for producing and publishing a catalogue from it.

[31] The patent dated February 4th 1603 is registered in the Resolutions of the Staten Generaal 12299, f xcix^{v}, Algemeen Rijksarchief in 's-Gravenhage (General State Archives, The Hague). An extract of it was included in *Spraeck ende woord-boeck*... (footnote 19).

[32] De Houtman (footnote 19), Introduction.

[33] Knobel (footnote 1), 420. The opinion expressed by Knobel still carries weight in the modern literature, see William B. Ashworth Jr., 'Halley's discovery of NGC 6231 and the hazards of early star nomenclature', *Journal for the History of Astronomy*, 12 (1981), 1–10 (p. 9, footnote 11).

[34] This conclusion was already reached by J. Stein, 'De oorsprong der zuidelijke sterrebeelden', *Hemel en Dampkring*, 20 (1922), 2–9, 33–8. Stein based his conclusion on a comparison between the data published by Merula (footnote 12) and the catalogue of De Houtman (footnote 19). Nevertheless, Stein maintained that De Houtman should be blamed for taking the credit from Keyser for the discovery of the southern sky.

From this point of view there is no need to raise the question (as some did) as to why Plancius did not defend the rights of the deceased Keyser when a patent was requested by Frederick de Houtman.[35] Neither do we have to explain why an honest and respectable man like Willem Jansz Blaeu co-operated with an imposter as Frederick de Houtman. The co-operation with Blaeu is, nevertheless, an important element in the history of the southern sky. Blaeu (then still named Willem Jansz of Alkmaar) started the production of celestial globes after his return in 1596 from Uranienborg, where, as is well known, he had spent some time as a pupil of Tycho Brahe.[36] In the same year that Hondius produced his first globe showing the new southern constellations, the first celestial globe of Blaeu (equal in size to that of Hondius) also appeared, but without the novel data on the southern sky.[37]

In those days the city of Alkmaar was an important centre of intellectual activity, inspired by the Metius family and men like Drebbel and Blaeu himself.[38] After his marriage in 1590, Frederick de Houtman also moved in these intellectual circles.[39] It seems, therefore, that Blaeu had been well informed by Frederick de Houtman about the astronomical survey carried out during the 'Eerste Schipvaart' when he was engaged in 1597 with the production of his first globe. Blaeu then probably also knew that all rights on the results obtained (including observations made by Frederick de Houtman) were claimed by Plancius and would more likely than not be put at the disposal of his competitor Hondius. The best way for Blaeu to obtain access to this novel data was, of course, to ask his fellow citizen to carry out a new series of observations during his forthcoming voyage. Thus there was a strong, economic, motive to undertake a second survey.

On the globes produced by Blaeu in 1606 and 1616, Blaeu very explicitly claims that De Houtman made his observations at his instruction, whereas De Houtman states in the introduction to his catalogue that it was the interest of navigators and lovers of astronomy (thus of science) that motivated him to carry out the project.[40] Of course the motives of Blaeu and De Houtman can well be regarded as complementing rather than excluding each other.

The involvement of Blaeu in the second survey also explains his rather passive attitude in the years following the production of his first globe. Clearly, it must have been irritating to Blaeu to see his major competitor Hondius publish one globe after another with the new data around the antarctic pole. Yet Blaeu waited and waited until the year of De Houtman's return home in 1602, when he published a 23-centimetre globe, his first one showing the new southern constellations.[41] A year later, in 1603, a

[35] Stein (footnote 34), 9.

[36] J. Keuning, *Willem Jansz. Blaeu: a biography and history of his work as a cartographer and publisher* (Amsterdam, 1973).

[37] Warner (footnote 1), 28.

[38] H. A. M. Snelders, 'Alkmaarse natuurwetenschappers uit de 16de en 17de eeuw', *Alkmaarse historische reeks*, 4 (1980), 101–22.

[39] Biographical data on Frederick de Houtman can be found in Mollema (footnote 28), 46–52. These data are based on notes by J. W. IJzerman in the Gemeente-Archief [= Municipal Record Office] Amsterdam, registered as Part. Arch. 742, no. 41. From these archives it is clear that Frederick de Houtman, through his marriage, was related to Cornelis Drebbel. The relationship between De Houtman and Adriaan Metius is acknowledged by Metius in *Institutiones astronomicae et geographicae, fondamentale ende grondelijcke onderwysinghe van de sterrekonst*... (Amsterdam, 1621), p. 4, and Adriaan Metius, *Nieuwe geographische onderwysinghe*... (Franeker, 1614), p. 29.

[40] Warner (footnote 1), 30 and Van der Krogt (footnote 16), 56.

[41] Van der Krogt (footnote 16), 59.

new edition of his 34-centimetre globe appeared, in which the empty region around the pole was also filled in.[42]

In both cases the credit for the observations of the stars around the antarctic pole is attributed to De Houtman, although the legend on the globe of 1603 is much more extensive than the one on the globe of 1602. This, we believe, is not without reason. We shall show in the next section, when comparing the data of the two globes, that something is obviously wrong. The data presented by Blaeu on his globe of 1602 appear to be unscrupulously copied from the globes published by Hondius previously; those of 1603 are different.

Can we explain this, at first sight, unnecessary deed of plagiarism by Blaeu? Might it not have been that the growing uncertainty about the chances of survival of Frederick de Houtman finally induced Blaeu, tired of waiting for his return home, to resort to copying the data of the southern constellations from his main competitor? The very fact that the data gathered by De Houtman during his second survey are carefully noted down on Blaeu's globe of 1603 indicates that the engravings for the 1602 globe were already finished by the time De Houtmen suddenly returned. We venture to conclude that Blau did not consider it worthwhile to do his already finished work on the small globe of 1602 over again. But, with the knowledge that newer (and, in Blaeu's opinion, better) data were now available to him for the production of his 34-centimetre globe, he did not hesitate to anticipate that production and to use Frederick de Houtman's name in the legend of his 1602 globe too.

Blaeu's activities show that the cartographic industry was in the first place an economic enterprise in which the legends of globes serve to advertize the product, not to acknowledge its contents. This should be borne in mind when interpreting the legend of the celestial globe published by Hondius Jr and Veen in 1613 (two years after the patent granted to Frederick de Houtman had expired). The presentation of the southern constellations on this globe is identical with those on the earlier globes of the publishing house of Hondius, i.e. it is based on the data from the first survey. Yet in the legend now the name of De Houtman is added to that of Keyser, no doubt primarily out of competitive motives.[43] Clearly, the information provided by globemakers in the legends of their globes can not always be taken at face value.

To our knowledge Dutch navigators did not obtain new data on the southern sky after 1603, as globes published after that date seem to confirm. The analysis of the data on the southern sky to be presented in the next section will, therefore, be confined to the published accounts of the two surveys described in this and the previous section.

4. Analysis of globes

In the previous section we have anticipated one or two conclusions drawn from our analysis of globes. In order to provide the necessary evidence we shall in this section investigate in some detail the question induced by previous studies, of whether the data in De Houtman's catalogue are authentic or not. Using this question as a guideline for our analysis also proved useful in determining what actually has been achieved by Dutch navigators at the turn of the sixteenth century.

[42] Ibid., 65.
[43] Ibid., 156.

4.1. *Extent of the exploration(s)*

The most direct way to verify the authenticity and originality of the catalogue of Frederick de Houtman would, of course, be to compare the data from this catalogue with the list of data available to Plancius upon the return of the 'Eerste Schipvaart'. Since we know about the latter list only from the globes published by Hondius and the account of it given by Merula, we cannot for certain determine its extent. However, if the data in De Houtman's catalogue were copied, one might expect a certain degree of similarity to exist between that catalogue and the published accounts of Plancius' list of data.

We have investigated this supposition first of all with regard to the extent of the data presented on the globe by Hondius of 1598, in the list of Merula published in his 'Cosmographiae' and in the star catalogue of De Houtman.[44] Since these three sources do not exhibit remarkable differences in the numbers of stars belonging to the twelve 'new' constellations that were introduced for the first time on the Hondius globe of 1598, any difference in extent should be sought for in those constellations other than the twelve new ones, for which data are presented in De Houtman's catalogue.

For these other constellations we have collected in Table 1 the number of stars within each constellation for the three sources mentioned above. Since most of these constellations were already described by Ptolemy we have also added in the table the relevant number of stars according to this classical description.[45]

Table 1. Southern constellations and their number of stars from various sources.

Name	Ptolemy	Merula	Hondius	De Houtman
Eridanus	34	38‖	38 (34)§	7 (1)§
Argo	45	45‖	54 (45)¶	56 (22)
Centaurus	37	34	32 (32)	48 (30)
Crux	(4)†	4‖	4 (4)	5 (4)
Fera	19	19	19 (19)	29 (15)
Ara	7	7	7 (7)	12 (7)
Corona Aust.	13	13	11 (11)	16 (9)
Columba Nohae	11‡	11‖	10 (10)	11 (11)
Scorpius (tail)	10	—	10 (10)	8 (8)
Total	176		185(172)	192 (107)

† The stars of Crux are included in the Ptolemaic catalogue under Centaurus.

‡ The stars of Columba are described as field stars under Canis Major in the Ptolemaic catalogue.

§ The numbers between brackets give the number of Ptolemaic stars included in the constellation.

¶ We assume that all forty-five Ptolemaic stars are presented on the Hondius globe of 1598, but we have not been able to verify this.

‖ In the text of Merula a reference is made to the 'Eerste Schipvaart' in the description of this constellation.

[44] Our analysis is based on the Hondius globes of 1598, recently located by P. C. J. van der Krogt, who kindly put photographs of these sources at my disposal. For the other sources, see P. Merula (footnote 12) and F. de Houtman (footnote 19).

[45] Ptolemaeus, *Handbuch der Astronomie*, 2 vols (Leipzig, 1963), II.

The first thing to note from this table is that only in four cases is a reference made by Merula to the 'Eerste Schipvaart', namely for Eridanus, Argo, Crux and Columba Nohae. We therefore assume that these four constellations were included in the survey carried out during that voyage.

A closer look at Eridanus indeed confirms that non-Ptolemaic stars (four in all) are depicted on the globe of Hondius of 1598 (Figure 1). The bright star named Alcarnar at the end of the river is situated underneath Phoenix and not, as it used to be, in the Ptolemaic presentation, underneath Cetus. Merula confirms that this extension of Eridanus was observed during the 'Eerste Schipvaart'. Since that journey Alcarnar, the last bright star of Eridanus, should be identified with α Eridani and not as before, with θ Eridani.[46]

Figure 1. The tail of Eridanus from the Hondius globe of 1598 (Photo: R. A. J. van der Krogt, Delft).

The situation is less clear for Argo, as this constellation is situated in a rather crowded region of the sky which renders the identification of the stars on the Hondius globe next to impossible. Even when numerical data are available, as in the case of De Houtman's catalogue, identification remains a great problem. Of the fifty-six stars described by De Houtman at least twelve cannot be properly identified.[47] In spite of

[46] See also Richard Hinckley Allen, *Star names: their lore and meaning* (New York, 1963), p. 217.

[47] A full account of the identification of all stars recorded in De Houtman's catalogue (footnote 19) shall be published in a separate paper together with a detailed numerical analysis. Part of this analysis is based on an unpublished investigation of De Houtman's catalogue carried out by H. J. Zwiers, a Dutch astronomer appointed at Leiden Observatory in 1907, in the Archives of the Museum Boerhaave, Leiden, registered as Arch. 282.

this, we believe that the comments provided by Merula and the excess in the number of stars on the Hondius globe above that in the Ptolemaic catalogue provide reason enough to suspect that 'new', non-Ptolemaic, stars were also observed in the region of Argo during the first voyage.[48]

The two other constellations (listed in Table 1) mentioned by Merula in reference to the 'Eerste Schipvaart' are Columba Nohae and Crux. Here a difficulty arises, for both constellations contain merely Ptolemaic stars. Therefore, their description could have been derived from earlier existing data.[49] In spite of this uncertainty, there are indications that Crux at least was observed during the 'Eerste Schipvaart'.

A constellation named Crux was introduced by Plancius already in 1589 on a globe in cooperation with Van Langren.[50] Relying on data from Portuguese and other navigators Plancius then situated Crux where now the tail of Dorado is located. The same constellation Crux is present on the celestial map included in the several editions of Plancius' world map (see Figure 2). The present constellation Crux, situated under Centaurus and entirely consisting of Ptolemaic stars, first appeared on the Hondius globe of 1598. This change in composition and location of Crux (which, by the way, must have been well known among navigators) indicates that its (averaged) right ascension was correctly determined only during the 'Eerste Schipvaart'. We presume that it must have been quite a surprise to Plancius to discover that he was already aware of the Southern Cross. Neither the data in Merula's Cosmographia nor those on the Hondius globe of 1598 indicate that more than the four constellations named above from the list in Table 1 were included in the observational programme carried out during the first voyage. The majority of the observations made refer to the twelve 'new' constellations.

We now turn to the last column of Table 1, in which the numbers of stars according to De Houtman's catalogue are given. From the numbers in parentheses we deduce that this catalogue describes a great many more non-Ptolemaic stars than are plotted on the Hondius globe. In other words, for the constellations listed in Table 1, De Houtman's data are much more extensive than those available to Plancius upon the return of the 'Eerste Schipvaart'. These data must have been collected by De Houtman himself during his second voyage in accordance with his own claim.

The conclusion reached here does not exclude the possibility that the data presented in De Houtman's catalogue on the twelve new constellations were copied from some presumed manuscript copy of the list of stars observed by Keyser. Since there is, as was mentioned before, a great similarity in the numbers of stars within each constellation, a more detailed analysis for these 'new constellations' has been made by us.

4.2. *Nomenclature of the 'new' constellations*

In most classical works on constellations Bayer's star atlas (1603) is usually referred to concerning the origin of the constellations around the south pole, in spite of the realization that some of them were already present on 'the now almost unknown globes

[48] We cannot exclude the possibility that some stars recorded by Ptolemy under Centaurus are included in Argo on the Hondius globe.

[49] Columba was introduced by Plancius on his world map of 1592, see Warner (footnote 1), 203. In Merula (footnote 12), 106, it is attributed to a globe produced by Van Langren, a statement we have not been able to confirm.

[50] Warner (footnote 1), 201.

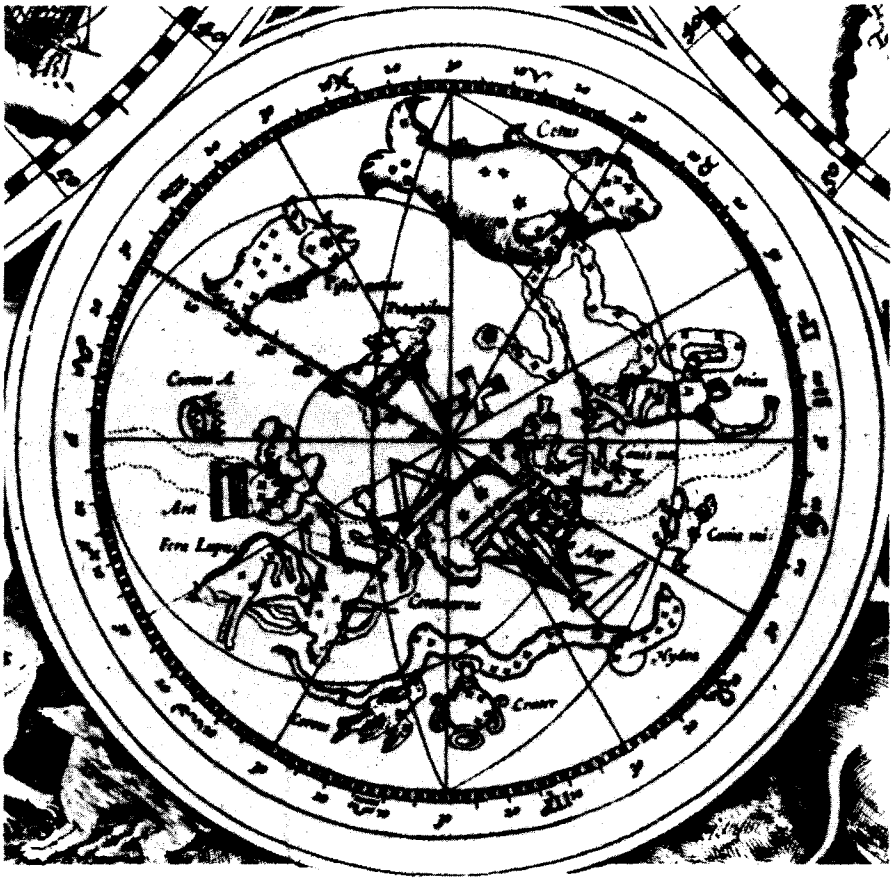


Figure 2. The map of the southern constellations from Plancius' world map of 1594. The constellation Crux is situated underneath Eridanus and not underneath Centaurus (Photo: Museum Boerhaave, Leiden).

of Emeric Mollineux, Jodocus Hondius and Jansenius Caesius (Willem Jansson Blaeu), of 1592 and the years following'.[51] Since very little is known about the early nomenclature of the 'new' constellations, we have summarized in Table 2 the names used on the globes published by Hondius and Blaeu, in the list of Merula and in the catalogue of De Houtman.

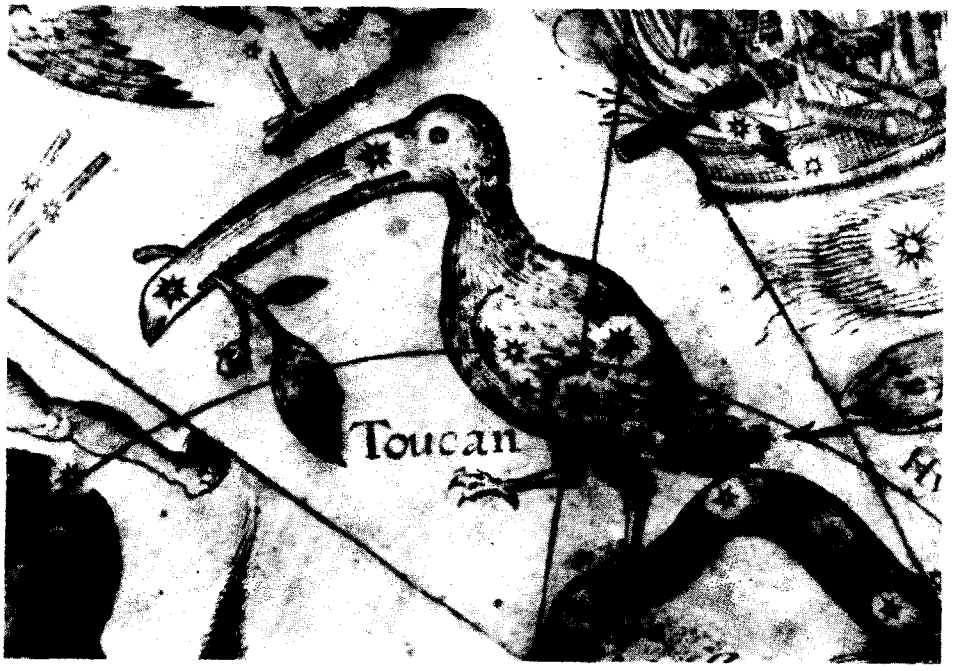
Upon comparing the names used on different globes one cannot escape the conclusion that they are remarkably similar. Minor differences occur in the naming of the Bird of Paradise (Paradijsvoghel etc.), which might be connected with the fact that an error (Apis instead of Avis) was introduced almost from the start.

The only striking feature that we derive in this respect from Table 2 is that a new name is introduced by Blaeu on his globe of 1603 for Toucan (see Figure 3). This new name, Pica Indica ab Indis Lang, also occurs in De Houtman's catalogue. The question arises why Blaeu did not use this new name on his 1602 globe. Its answer will become obvious below.

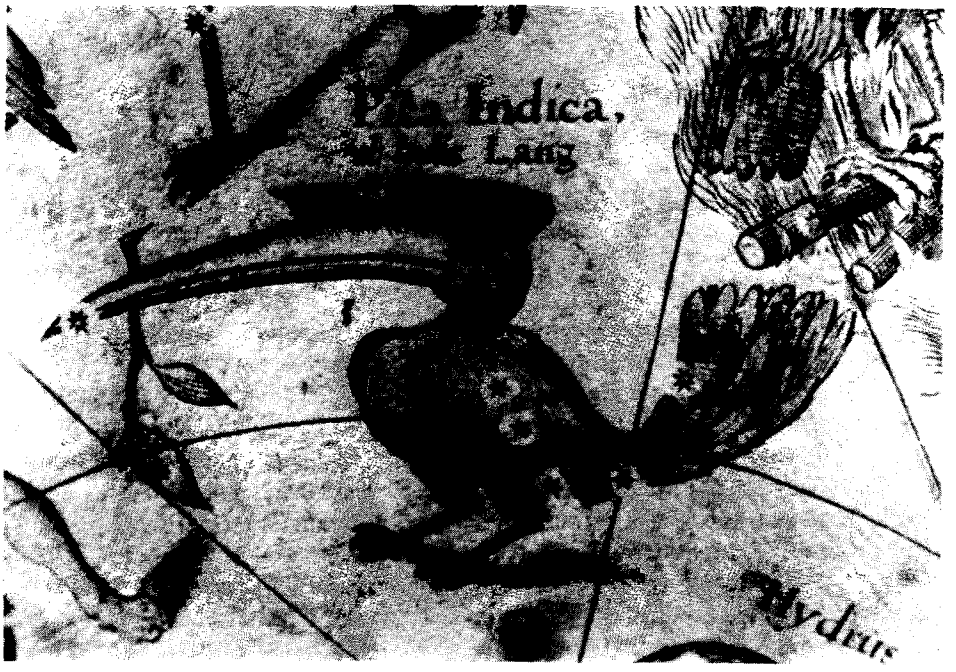
[51] Allen (footnote 46), 14.

Table 2. Early nomenclature of the new southern constellations.

	Merula's Cosmographiae (1605)	Hondius/Plancius 35·5 cm globe (1598)	Hondius 35·5 cm globe (1600)	Hondius 20 cm globe (1601)	Blaeu 23 cm globe (1602)	Blaeu 34 cm globe (1603)	De Houtman Catalogue (1603)
1	Phoenicopterus/ Roodtvleugel	Grus/Krane	Krane/Grus	Crane/Grus	Grus	Grus	Den Reygher
2	Phoenix	Phoenix	Phoenix	Phoenix	Phoenix	Phoenix	Den Voghel Fenicx
3	Indus	Indiaen/Indus	Indiaen/Indus	Indiaen/Indus	Indus	Indus	De Indiaen
4	Pavus	Pau/Pavo	Pau/Pavo	Pavo	Pavo	Pavo	De Pauw
5	Paradijsvoghel/ Avis Paradisi	Paradysvogel/ Apis Indica	Paradysvogel/ Apis Indica	Paradysvogel/ Apis Indica	Apes Indica	Apous Indica	De Paradijs Voghel
6	Musca Indica	—	—	—	Musca	Musca	De Vlieghe
7	Chamaeleon	Chamaeleon	Chameleon	Chameleõ	Chamaeleon	Chamaeleon	Het Chamel joen
8	Triangulus Australis	—	Triangulum Aust.	Triangulum Aust.	Triangulum Austrinum	Triangulum Austrinum	Den Zuyder Triangel
9	Hirundo Marina/ Zeezwaluwe	Vliegenden Vis	Vliegenden Visch	Vliegenden Visch	Avis Volucris	Piscis Volucris	De Vlieghende Visch
10	Aurata/Dorado/Zee Braesum and Vliegende Visch	Dorado	Dorado	Dorado	Dorado	Dorado	Den Dorado
11	Pica Brasilica/ Toucan	Toucan	Toucan	Toucan	Toucan	Pica Indica ab Indis Lang	Den Indiaenschen Exster of Indies Lang
12	Waterslanghe/ Hydrus Polaris	Waterslange/ Hydrus	Waterslange/ Hydrus	Waterslange/ Hydrus	Hydrus	Hydrus	De Waterslang
13	Grus	Field stars	Field stars	Field stars	Field stars	Field stars	—



(*a*)



(*b*)

Figure 3. Toucan as depicted on the globes of Blaeu of (*a*) 1602 and (*b*) 1603 (Photo: R. A. J. van der Krogt, Delft and Museum Boerhaave, Leiden).

The similarity in nomenclature used by Hondius, Blaeu, and De Houtman has been used as an argument for the already mentioned accusation of plagiarism on the part of De Houtman. However, the use of the same constellations does not imply identical presentations. Moreover, De Houtman never claimed to have invented these constellations. The similarity in nomenclature as such forms, therefore, no argument against or in favour of De Houtman's plagiarism. All one can conclude from Table 2 is that the data in the catalogue of De Houtman (whether copied or newly observed), have been organized along the scheme of constellations first published on the globe of Hondius of 1598.

Of more interest than the similarity between the names used by Hondius and Blaeu is the disagreement that we note between Hondius and Merula, since these two sources refer to the *same* survey. In Merula's list for instance, Grus is composed of a number of stars that appear as field stars on the globes of Hondius and in Merula's version Dorado and Piscis Volans are one and the same constellation. We shall return to this point in more detail when we discuss the problems connected with the origin of the constellations (not to be confused with the origin of the astronomical observation of the stars themselves). First, however, we must look in some detail at the composition of the new constellations.

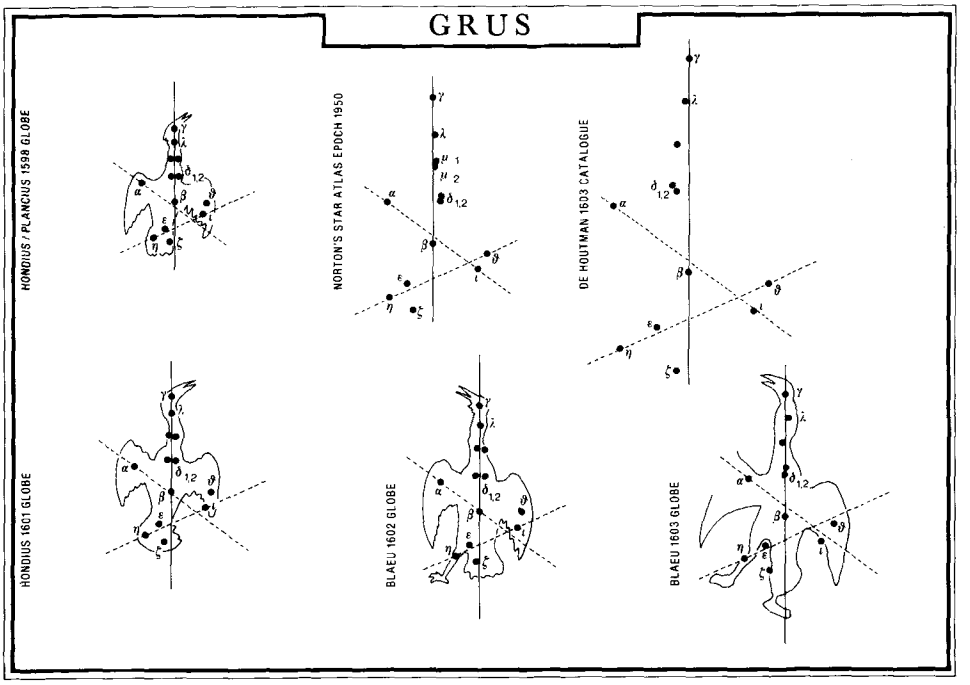


Figure 4. Grus.

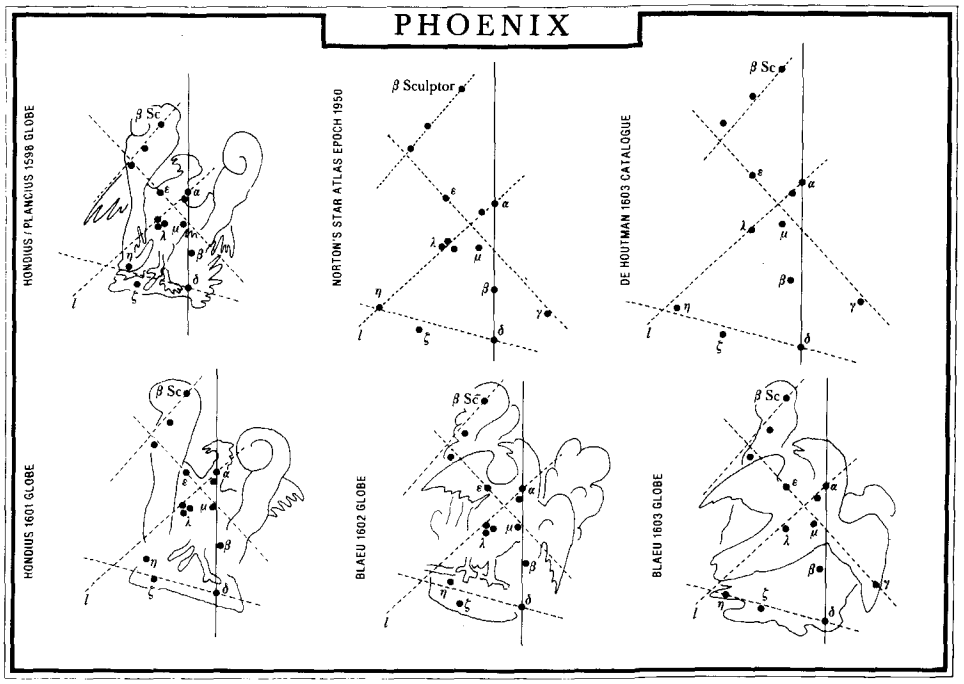


Figure 5. Phoenix. The declination of β Sculptor according to De Houtman has been corrected for a printing error of 5°.

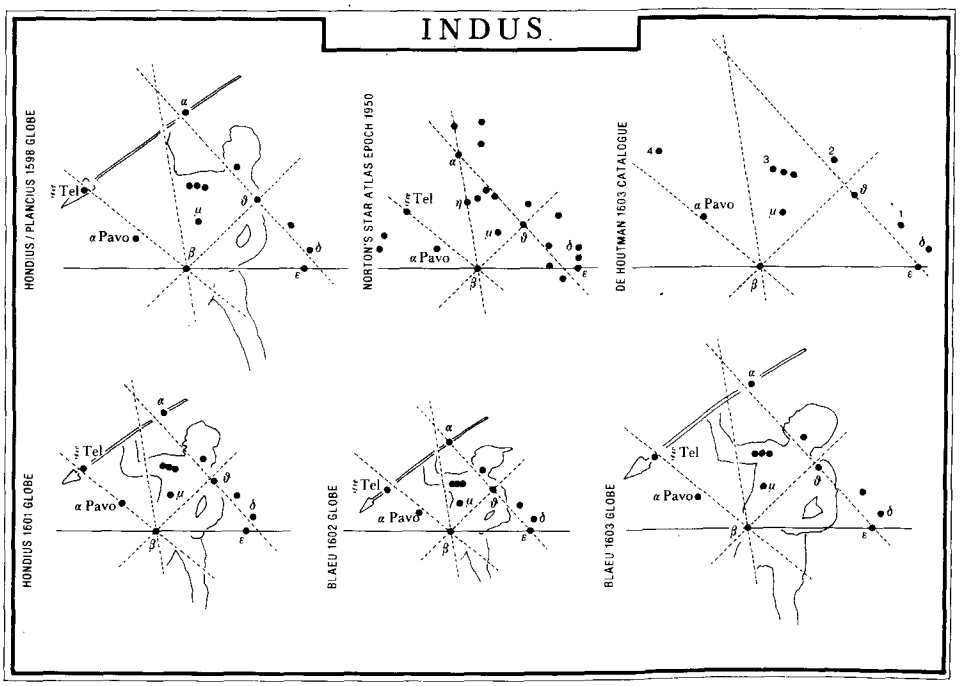


Figure 6. Indus. Unidentified stars are numbered 1–3 in the presentation of De Houtman.

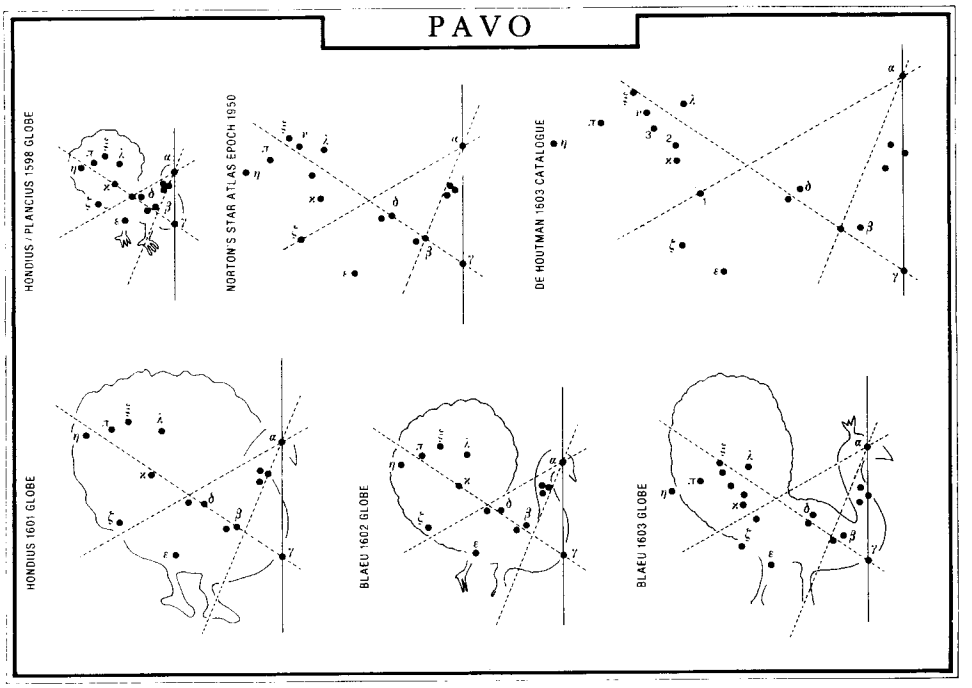


Figure 7. Pavo. Unidentified stars are numbered 1–3 in the presentation of De Houtman. The right ascension of α and γ Pavonis according to De Houtman has been corrected for a printing error of 30° and 10°, respectively.

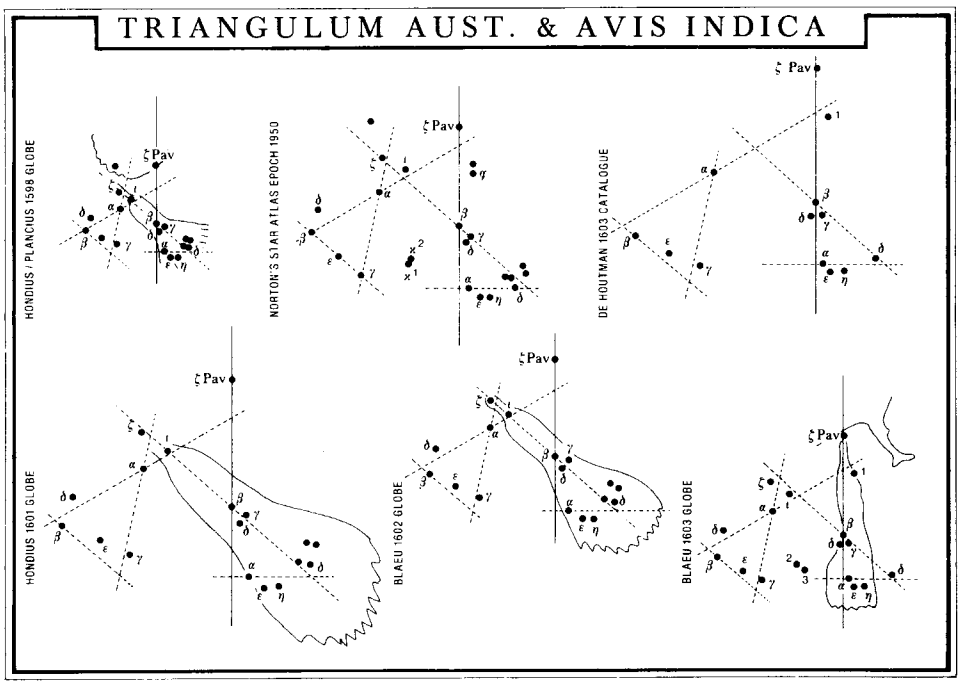


Figure 8. Triangulum Austr. and Avis Indica.

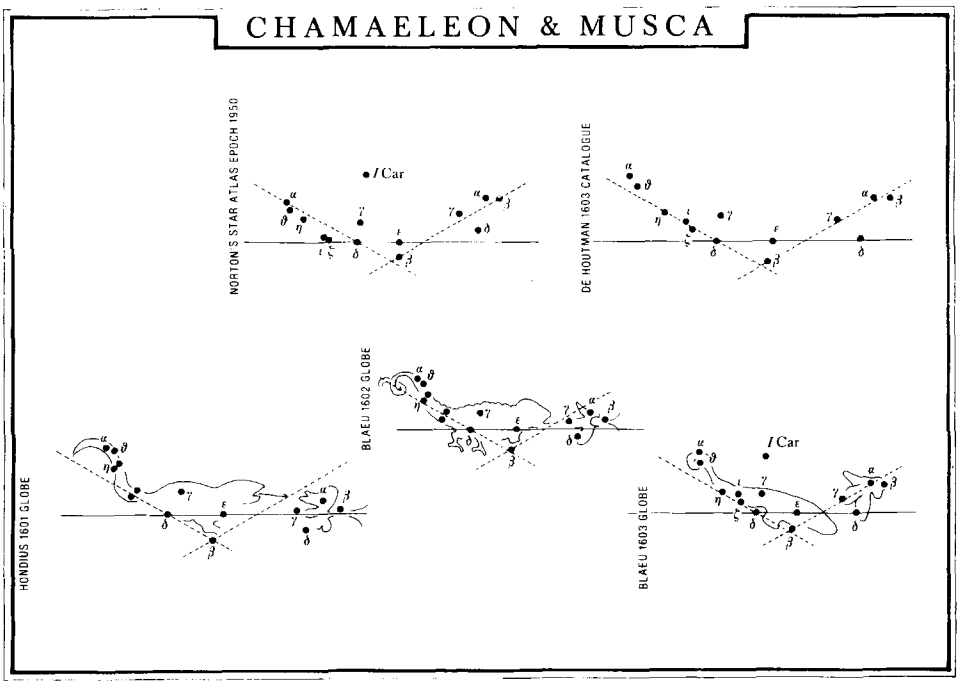


Figure 9. Chamaeleon and Musca. The data for these constellations from the Hondius globe of 1598 have been omitted since the available material only provided incomplete data.

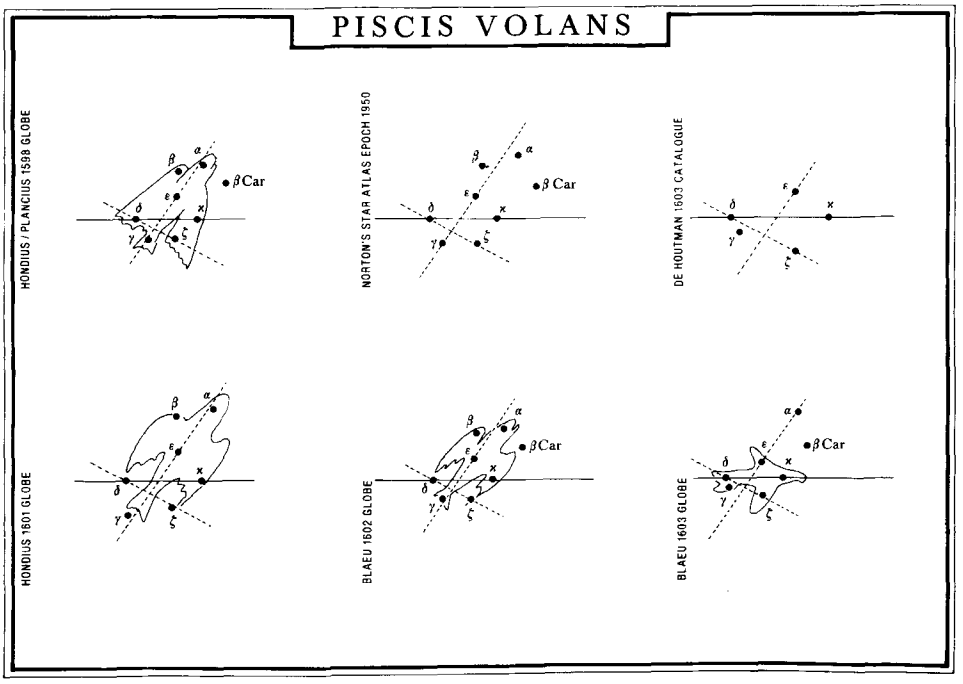


Figure 10. Piscis Volans.

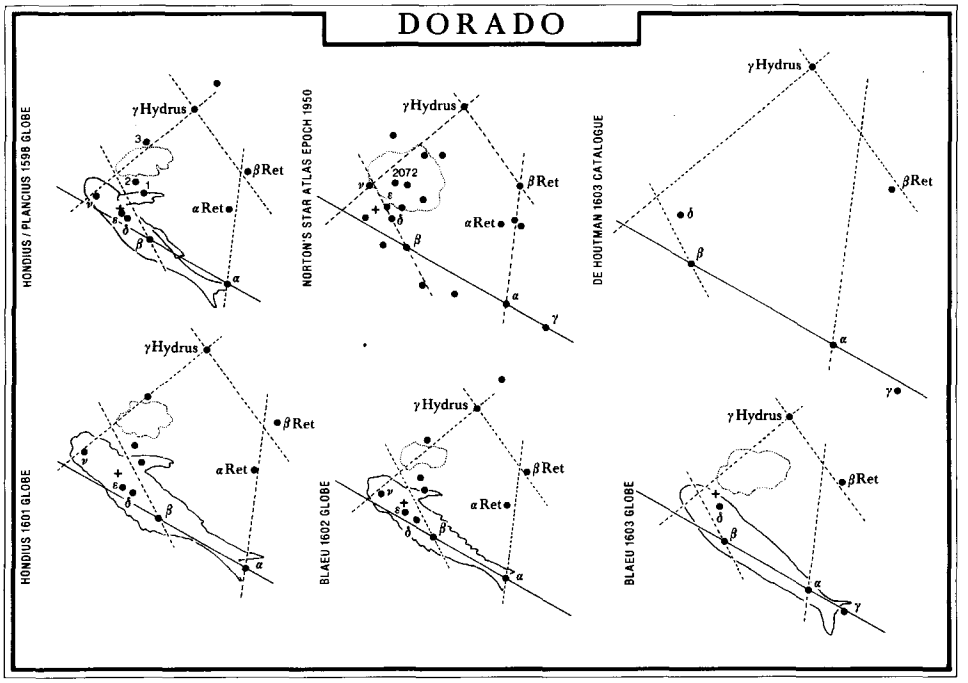


Figure 11. Dorado. The unidentified stars on the Hondius globe are numbered 1–3. The identification of the stars within this constellation is based on the fact that ν, ε, δ and β are more or less on a straight line.

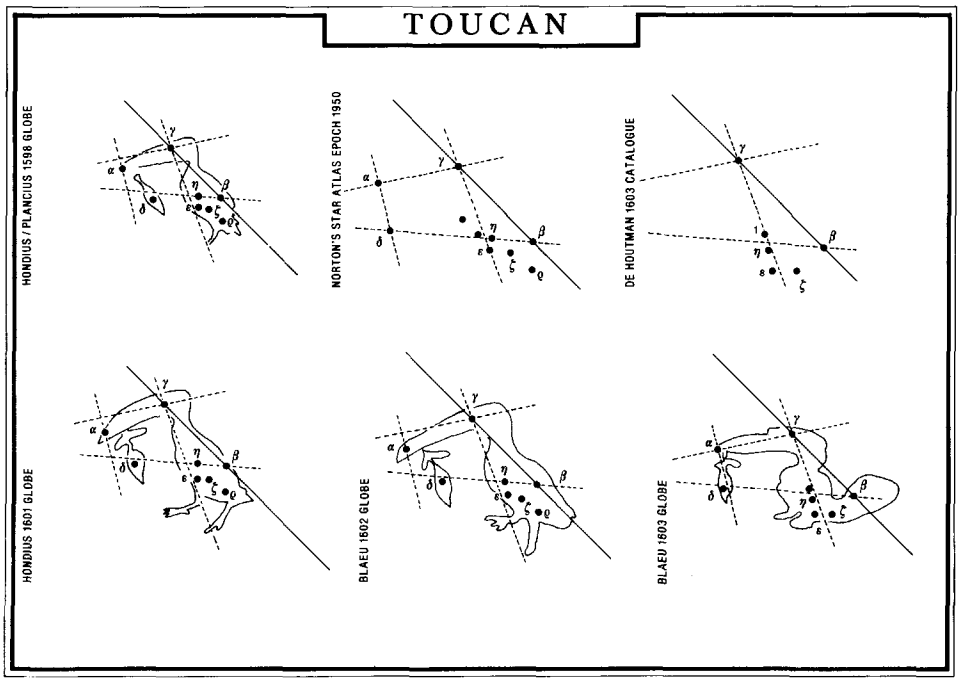


Figure 12. Toucan.

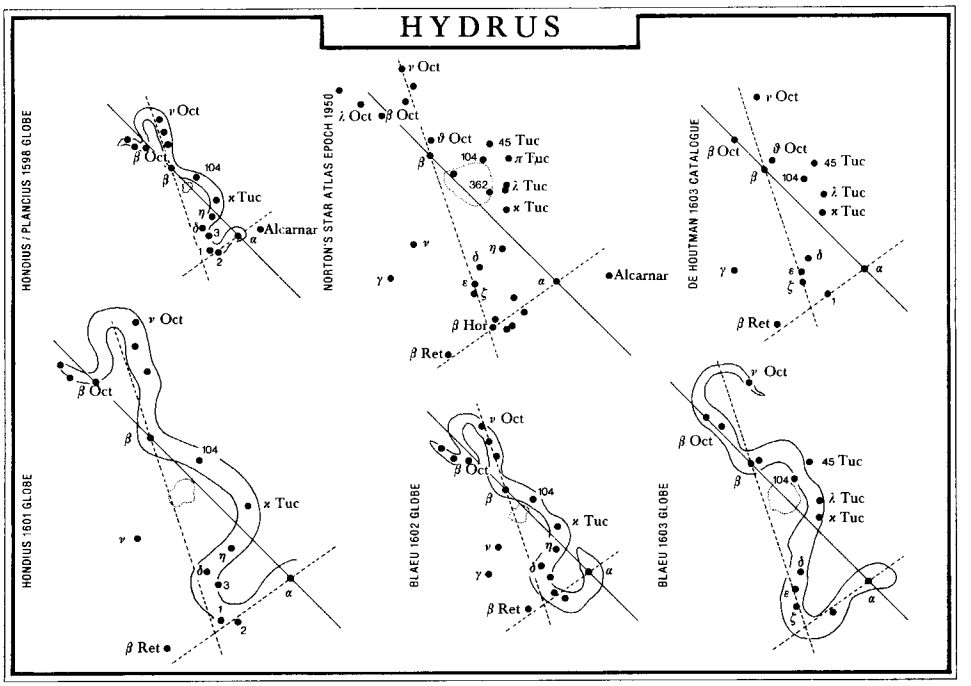


Figure 13. Hydrus.

4.3. *Composition of the 'new' southern constellations*

One of the difficulties in the analysis of globes is that no direct numerical data are available. Since we deal here with old and rare objects, usually the only means to study them carefully is by using photographs[52]. The question naturally arises whether the available material is suitable for ascertaining whether or not the data on the composition of the twelve constellations as described by De Houtman agree (more or less) with their presentation on the globes of Hondius.

To find this out we have reproduced in Figures 4 to 13 for each constellation concerned its composition as derived from a number of globes, the catalogue of De Houtman, and the modern Norton's star atlas.[53] This latter source was added for the purpose of identification. As a check on our method of comparison we have included the data of two globes of Hondius (of different sizes), presuming that the presentation on the globe of 1601 was a copy of that presented on the Hondius/Plancius globe of 1598. Besides these two we have included two globes of

[52] The data presented here and hereafter in the analysis of the composition of the constellations were derived from globes in the collections of the Rijksmuseum Nederlands Scheepvaart Museum, Amsterdam (globes of Hondius and Blaeu of 1600 and 1602, respectively), and the Museum Boerhaave, Leiden (globe of Blaeu of 1603). Also photographs were used of the globes in the collections of the Stift Kremsmünster, Osterreich (globe of Hondius of 1601), and the Koninklijke Bibliotheek, Brussel (globe of Blaeu of 1602). These photographs were made available to me by R. A. J. van der Krogt. The data on the globe of Hondius of 1598 were derived from material kindly put at my disposal, prior to publication, by P. C. J. van der Krogt. See also P. C. J. van der Krogt, 'The globe-gores in the Nicolai-collection (Stuttgart)', *Der Globusfreund* (March, 1985), 99–116 (p. 99, no. 24). Apart from the catalogue of De Houtman (footnote 19) we also used maps from the unpublished investigation by Zwiers (footnote 47).

[53] Arthur P. Norton, *Norton's star atlas...*, 17th ed (Cambridge, Massachusetts, 1978).

Blaeu (also differing in size) since according to their legends they both represent data from De Houtman's catalogue, and as such serve as an intermediary source between the catalogue of De Houtman and the globes of Hondius.

In order to facilitate a comparison between the data from these different sources we have given all presentations the same orientation. For example, in Figure 5, after identifying α and δ Phoenicis in each presentation, we have oriented vertically the line connecting these stars. Next we provided each representation with a set of parallel lines with directions defined by the modern version of the constellation. For instance, the line indicated by *l* in Figure 5 is obtained in each representation by drawing through α Phoenicis a line parallel to the line connecting α and η Phoenicis in the modern presentation. In this way the structure outlined by the modern version is transferred to the other representations without the need to scale the latter.

Such scaling is next to impossible, considering the differences in source material: photographs of globes of different sizes, taken under different angles with different magnifications (Hondius/Plancius 1598 globe, Hondius 1601 globe and Blaeu 1602 globe), drawing directly taken from globes (Blaeu 1603 globe) and maps (catalogue of De Houtman and Norton's star atlas). As a check we used also gores of the Hondius/Plancius 1598 globe, drawings of the Blaeu 1602 globe, and photographs of the Blaeu 1603 globes. The results to be presented here were not changed by including these additional samples of source material.

Only in one of the twelve constellations did we encounter problems that must be ascribed to the use of photographs. This concerns Hydrus (Figure 13), a constellation that extends over a considerable part of the sky. As a consequence the figures outlined by the data from the two Hondius globes differ—depending on the chosen orientation—in the orientation of the tail. In all other cases the presentations of these two globes are identical in the sense that firstly, the same stars are present within each constellation and secondly, the relative positions of the stars within each constellation are identical. The general agreement between the data derived from the two Hondius globes convinces us that the method employed here and the material used is, indeed, suitable for recognizing identical patterns.

With the data arranged in the way described above we are now ready to make a detailed comparison. For this purpose we have summarized in Table 3 the total number of stars for each constellation according to the different sources as shown in Figures 4–13. For the sake of completeness we have also added here the number of stars given by Merula. The first conclusion derived from this Table concerns the overall agreement between the numbers mentioned in the descriptive list of Merula with those derived from the Hondius globes. We therefore proceed with the assumption that the data presented on the Hondius globes are representative for the list of Plancius. The second conclusion, as far as the numbers are concerned, is that among the various globes three can be matched with each other. These are the globes of Hondius of 1598 and 1601 and, surprisingly, *the 1602 globe of Blaeu.* This agreement is sustained when we consider the relative positions of the stars within constellations for these three globes. All deviations in the representations on the Hondius globes from the modern representation (for example the strongly deviating positions of α and δ Tucanae (Figure 12), of ν, ε and δ Doradûs (Figure 11), of the location of Musca with respect to the Chamaeleon (Figure 9)), are faithfully reproduced on the 1602 globe of Blaeu. The agreement is so striking that the following conclusion appears irrefutable, namely *that there is no difference whatsoever between the composition of the constellations as presented on the two globes of Hondius and on that of Blaeu of 1602.*

Table 3.

Source[52] Constellation	List Merula (1605)	Globe Hondius/Plancius (1598)	Globe Hondius (1600/1601)	Globe Blaeu (1602)	Globe Blaeu (1603)	Cat. De Houtman (1603)	Stars in common between Blaeu (1603) and De Houtman	Stars in common between Hondius and De Houtman	New stars according to De Houtman
Grus	13	13	13	13	12	12	12	12	—
Phoenix	14	14	14	14	13	13	13	12	1
Indus	12	12	12	12	12	11	11	11	—
Pavo	15	16	16	16	19	19	19	15+1†	4
Avis Indica	12	12	12	12	9	9	9	7+(1)†	1
Musca	4	4	4	4	4	4	4	4	—
Chamaeleon	10	10	10	10	9	9	9	9	—
Triangulum Aust.	4	5	5	5	5	4	4	4	—
Piscis Volans	7	7	7	7	5	5	5	5	—
Dorado	6	6	6	6	4	4	4	3	1
Toucan	8	8	8	8	8	6	6	5	1
Hydrus	15	15	15	15	14	15	13+(2)‡	8+(2)‡	5
Running total	120	122	122	122	113	111	109	96	13
Field stars	6	6	6	6	7	0	2‡	2‡	3§
Grand total	126	128	128	128	120	111	111	98	13+3§

† In the catalogue of De Houtman ζ Pavonis is described under Avis Indica (see figure 8). For completeness sake we therefore have added this star also under Avis Indica (placed within parentheses in order that it is not counted twice).

‡ In the catalogue of De Houtman two stars under Hydrus are described, which on Blaeu's globe of 1603 and on the globe of Hondius of 1598 appear as field stars. For the sake of completeness, we have here, too, placed these two stars within parentheses under Hydrus.

§ We refer here to the field stars κ_1, κ_2 Pavonis (see figure 8) and I Car (see figure 9) which appear only on the globe of Blaeu of 1603. We assume that these stars were observed by De Houtman but for some unknown reason not included in his catalogue.

Finally, a third conclusion follows from Table 3. Two other representations agree very well with each other, namely that of the 1603 globe of Blaeu and the catalogue of De Houtman, although the agreement in numbers is less striking than in the former case. However, in seven of the ten cases that the number of stars derived from De Houtman's catalogue differs from that derived from the Hondius globes, that on Blaeu's globe agrees with De Houtman's list. When comparing the numbers of stars that occur simultaneously in the catalogue of De Houtman and on the globes of Hondius and Blaeu (of 1603), it becomes clear that of the 111 stars recorded in the catalogue only 98 are present on the Hondius globes, whereas all 111 are depicted on Blaeu's globe (Table 3, ninth and tenth columns).

Clearly, De Houtman's catalogue contains thirteen stars that were recorded for the first time. The agreement between Blaeu's 1603 globe and the catalogue of De Houtman is further supported when the relative positions of stars within a constellation are considered. Deviations in the data of De Houtman from the modern representation (for example, the (relative) position of γ Piscis Volantis (figure 10) and ξ Pavonis (Figure 7), the unidentifiable stars (1, 2, 3) in the tail of this latter constellation) are also present on Blaeu's 1603 globe.

Occasionally, however, Blaeu's representation seems to deviate from De Houtman's catalogue in two respects. Firstly, nine stars present on the 1603 globe are lacking in the catalogue of De Houtman. These are: α Indus, κ_{11} and κ_{12} Apus, δ Triangulum Australe, α Piscis Volans, α and δ Toucan, λ Octanis, and I Car. Some, but not all, of these nine stars are present on the Hondius globes. Secondly, we do find in a few cases small differences in the relative positions between De Houtman's catalogue and Blaeu's 1603 globe, as in the case of the tail of Chamaeleon (Figure 9) and the nape of the neck of Grus (Figure 1). However, in both cases better agreement appears to exist between Blaeu's 1603 version and De Houtman than between the Blaeu and Hondius versions. These differences might have been caused simply by inaccuracy in the plotting of the data on the globes. We therefore consider it justified to draw another important conclusion based on the data presented here, namely *that there exists a very good, albeit not complete, agreement between the composition of the constellations as described by De Houtman in his catalogue and that presented on the globe of Blaeu of 1603.*

From the comparison made above we conclude that between the sources studied here two versions can be recognized, the first one being presented on the globes of Hondius *and* on that of Blaeu of 1602, and the second one presented in De Houtman's catalogue and on Blaeu's globe of 1603.

If one wants to remain suspicious one can maintain that this is no hard proof for the authenticity of the data in De Houtman's catalogue. For one might argue that if these data had been copied, the copying would have been done after Keyser's death but before De Houtman's arrival back in Amsterdam. At that time one might also argue that the data were not yet nicely processed into a catalogue. The processing of the data, presumably done by De Houtman himself, could in some unpredictable way have led to differences between the first and second versions.

Apart from the fact that we see no need to be so suspicious, we think that we may use two criteria to distinguish a 'processed' copy from a new set of independent data. The first one concerns the addition of new data. When comparing the first and the second versions we find that new data have been added for the constellations Phoenix, Pavo, Avis Indica, Dorado, Toucan and Hydrus. The second criterion concerns structural changes between the two versions. These clearly occur for Grus, Pavo, Chamaeleon, Musca and Dorado. The significance of this criterion is enforced by the one notable

exception for which the criteria do not hold, namely the curious case of the constellation Indus (Figure 6).

The presentation of this constellation appears to be identical in all five sources studied. No noticeable differences can be traced. What is more, all sources include the same unidentifiable stars (numbered 1, 2 and 3 in De Houtman's version of Indus). These stars can only be identified if tremendous errors in the observed positions are assumed, and it is hardly possible that similar errors would be measured twice. Consequently, the data in De Houtman's catalogue for Indus must be related to those collected during the 'Eerste Schipvaart'. In other words, this constellation shows what we might expect if the data in the catalogue were indeed related to those plotted on the Hondius globe. Since such mutual agreement is observed nowhere else, we conclude that the structural differences between the two versions distinguished above cannot be explained by the hypothesis that the one is a copy of the other. Therefore, it can be assumed that De Houtman's catalogue is both original and authentic. We now turn towards a few other interesting conclusions which we can derive from the present analysis.

It is clear from the extent of the first survey that the instructions for the astronomical programme were intended to produce a rather complete description of the empty regions of the southern sky (Figure 14). In the regions covered by the twelve new constellations only three out of the thirty-nine stars with magnitude brighter than 4^m are lacking. Of the one-hundred stars brighter than the fifth magnitude only eleven remained unrecorded.[54] The second survey, on the other hand, included stars with latitudes above 35°. It covers therefore a much more extended region of the sky. Since most of the bright stars of the twelve new constellations had been observed for the first time during the first survey, most of the stars newly recorded by De Houtman lie outside the regions covered by these twelve. After the second survey, however, all stars brighter than the fourth magnitude were recorded, whereas of the stars brighter than the fifth magnitude only six stars remained unrecorded. These are ε, γ, δ Reticuli, ε, λ Muscae, and τ Phoenicis.

As far as the quality of the two surveys is concerned our analysis indicates that in some cases the second survey can be considered as an improvement on the first one (comparing with modern data) but in other cases not. However, it is not to be expected that the second survey would be much more accurate than the first one, with the instruments available, in spite of the fact that De Houtman himself or Blaeu might have thought so. One can estimate that the positional accuracy of the two surveys was, on average, of the order of 0·5 degree, quite consistent with what one might expect from observations carried out with an astrolabe or a back staff.[55]

Another interesting conclusion relates to the arrangements of the stars into constellations. It is now clear that the new constellations, after having been introduced for the first time on the Hondius globe of 1598, were taken over by De Houtman and Blaeu, apart from some minor details. These consisted of a new name for Toucan, as already stated before, and a few slight rearrangements of some constellations, namely changes in the orientations of Apis Indica (Figure 8), Piscis Volans (Figure 10) and the

[54] These estimates are based on the data provided by B. A. Gould, *Uranometria argentina* (Cordoba, 1879).

[55] A more detailed account of the instrumental aspects of the survey carried out by Frederick de Houtman shall be given in the paper announced in footnote 47.

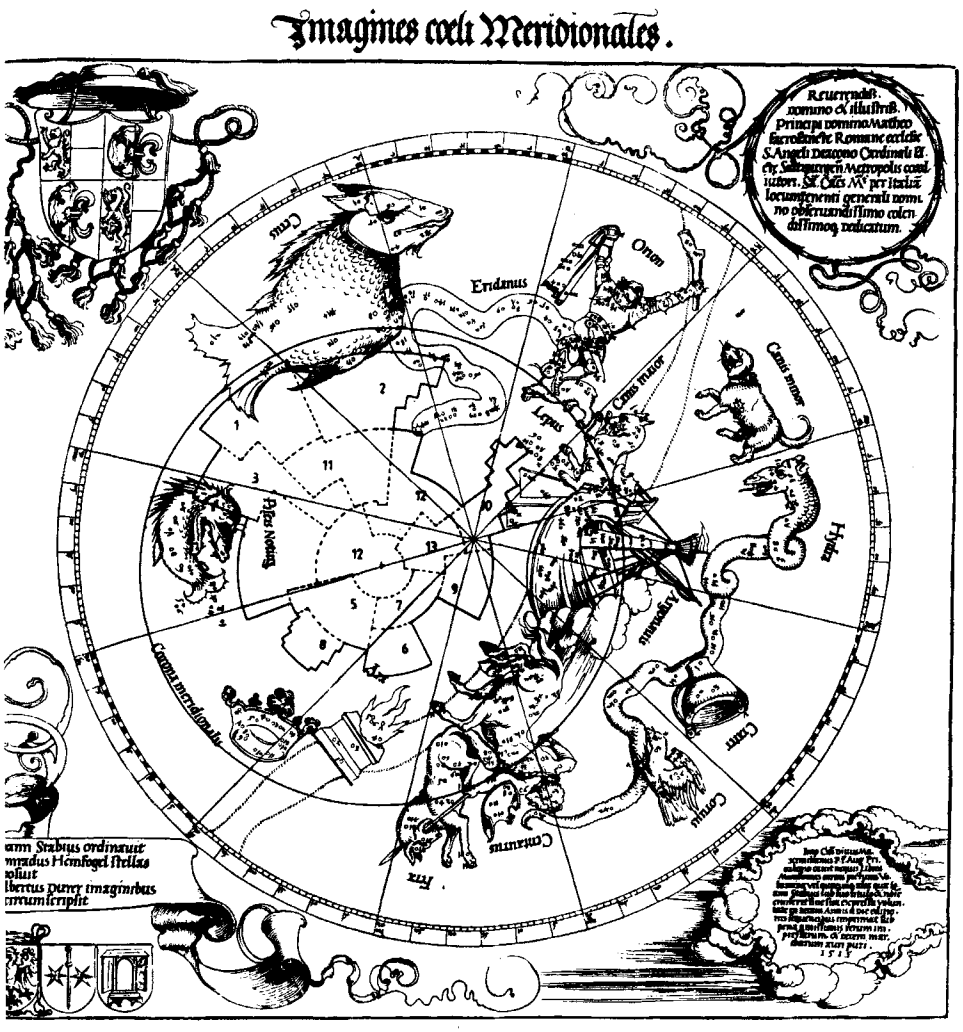


Figure 14. Superimposed upon a map of the southern celestial sky (by Dürer, 1515) the parts of the sky covered by the first and the second survey are indicated. The areas numbered 1–13 were charted during the first survey (see Table 2 for the constellation names corresponding to these numbers). The second survey covered the area enclosed by the declination circle of 35° (full circle).

tail of Hydrus (Figure 13). The 'inventor' of the twelve new constellations (if there was one) must therefore be sought for among those involved in the first survey, as we shall do in the next section.

5. The origin of the 'new' constellations

In most studies of the Dutch explorations of the southern stars no clear distinction has been made between the observations of the positions of the stars on the one hand and the arrangement of stars into constellations on the other.[56] Consequently, Keyser

[56] J. Stein, 'De Hemelglobe van Jodocus Hondius van 1600', *Jaarverslag van de Vereeniging Nederlandsch Historisch Scheepvaart Museum te Amsterdam*, 13 (1929), 42–7 (p. 47).

has usually been credited with the formation of the new constellations and De Houtman blamed for taking the credit from him.

We have already drawn attention to the fact that Frederick de Houtman never claimed to have grouped the stars he observed into new constellations. Let us therefore turn to the question of whether indeed Keyser should deserve the credit for the invention of the new southern constellations.

From the acknowledgement by Plancius on the Hondius globe of 1598 it is very clear that Keyser and other lovers of astronomy are credited with having made the observations. Nowhere, however, is credit for arranging the stars into new constellations attributed to Keyser. It is only in the account of Merula that such a claim on Keyser's behalf is made and then only indirectly. For when Merula discusses the new constellations, he attributes the shortcomings of the choices to the lack of experience in these matters by this otherwise experienced navigator.[57] Clearly, Merula makes here the tacit assumption, as other historians did after him, that the observer should be identical to the namer (inventor) of the constellations.

The identification of observers with inventors of constellations appears to be a notion that is hard to resist. In the valuable inventory *The Sky Explored* by Warner it is encountered in comments added to the description of Blaeu's globe:

> Pieter Dirksz Keyser and Frederick de Houtman, at the end of the sixteenth century charted the southern stars and *grouped them into constellations.*[58]

However, in the description of the various globes and maps produced by, or in cooperation with, Plancius, Warner recognized at the same time that

> If these various globes can be trusted at face value, and I see no reason why they should not be, it appears that Plancius was the inventor of ten celestial constellations..., in addition to Columba and Polophylax. And he probably had a hand in the selection of the twelve constellation figures described by Keyser and Houtman as well.[59]

The evidence presented by Warner for Plancius' involvement in the invention of new constellations increases in importance once it is realized that in all cases that on Dutch maps or globes new constellations were produced in the first decades of the seventeenth century, Plancius appears to be the author of the map or globe. Evidently, Plancius could not withstand the temptation to make new constellations, whenever he had the opportunity to do so. His activities, moreover, were not restricted to newly recorded stars either. For Columba Nohae, introduced for the first time on his world map of 1592, is composed of the field stars below Canis Major. These stars were known since antiquity, but apparently no one before Plancius had felt the need to arrange them into a constellation. Does, therefore, not Keyser but Plancius deserve the full credit for the formation of the new southern constellations? After all, Keyser unexpectedly died during the voyage in September 1596. It would be plausible that at the time of his death his observations (like those of the other observers) were arranged according to certain groups of stars, but most unlikely that at that time it had been already decided which group of stars should be represented by a fish, an Indian or a Toucan. Nor is it likely

[57] Merula (footnote 12), 105.
[58] Warner (footnote 1), 30.
[59] Warner (footnote 1), 206.

that Plancius, with his great interest in the invention of new constellations, would have left this naming to Keyser or anyone else. Plancius' involvement in the making of the new constellations is further supported by our analysis of the early nomenclature of these constellations.

If the actual list of constellation names published by Merula is compared with those published on the Hondius globe (see Table 2), a number of differences can be seen. In order to explain them one must assume that at least two different versions of the list of new constellations did exist, one being of a later date than the other. Since the globe published by Hondius is not mentioned by Merula, whereas one published by Van Langren is, the list published by Merula probably predates the list of constellations published on the Hondius globe of 1598.[60] In other words, the final choice of constellations was made by no-one else but Plancius himself.

With Petrus Plancius being the man behind the formation of the twelve new constellations, the choice for the naming of these constellations is easily explained. Clearly, this choice was strongly influenced by the fascinating pictures of the New World obtained by voyages of discovery. Many illustrations of the flora and fauna from the new southern world were reproduced on maps describing the new lands.[61] The most illustrative example is the edition of Plancius' world map of 1594, the border of which is richly decorated by a toucan, a bird of paradise, a chamaeleon, and many other exotic animals.[62]

This cartographic tradition might explain why the choice of the new constellations is not limited to animals from the Indonesian archipelago, but includes also a South American bird. Another source of inspiration may have been the descriptions of the flora and fauna gathered during the 'Eerste Schipvaart' itself. Of the twelve constellations, four can be traced back to illustrations in the Journals of the 'Eerste Schipvaart', namely Indus, Dorado, Chamaeleon, and Piscis Volans (Figures 15 and 16), whereas also a vivid description is included of the 'wildness of the peacock'.[63] It is remarkable that not all constellations can be traced back to the New World. Notable exceptions are Phoenix, the Southern Triangle, and Hydrus, which obviously fit better into the classical tradition. Of all men involved, Plancius must surely have been the one best acquainted with that tradition too.

Summing up, we conclude that Petrus Plancius was, more than anybody else, inclined to and capable of forming new constellations from the newly recorded stars. Since he alone had access to the data gathered by Keyser and the other lovers of astronomy, he alone had the opportunity to do so. It is hard to believe that he would have refrained from it under the circumstances. Therefore, Petrus Plancius and no one else deserves the credit for having introduced and named the twelve new constellations of the southern sky.

[60] Warner (footnote 1), 203, expresses surprise that the world map (outdated by the new results on the southern sky) is included in Merula's *Cosmographiae* (footnote 12). However, as Stein (footnote 34) pointed out, Merula obtained a commission to write another important book (*Historia Belga*) in December 1598, by which the progress of the *Cosmographia* most likely was delayed. When finally the 1358 pages of this latter work were finished, he apparently did not bring the first few hundred pages, written in 1597–1598, up to date.

[61] Wilma George, 'Sources and background to discoveries of new animals in the sixteenth and seventeenth centuries', *History of Science*, 18 (1980), 79–104 (pp. 87, 94).

[62] The world map of Plancius edited in 1594 is often found in Jan Huygen van Linschoten, *Itinerario* (Amsterdam, 1596). I used a photograph of it, included in J. J. Vredenberg-Alink, *Spiegel der Wereld* (Utrecht, 1969), 56–7. See also Warner (footnote 1), 202.

[63] Rouffaer and IJzerman (footnote 2) I, 14, 52, 134.

Figure 15. Drawing of an Indian from the journals of the first voyage.

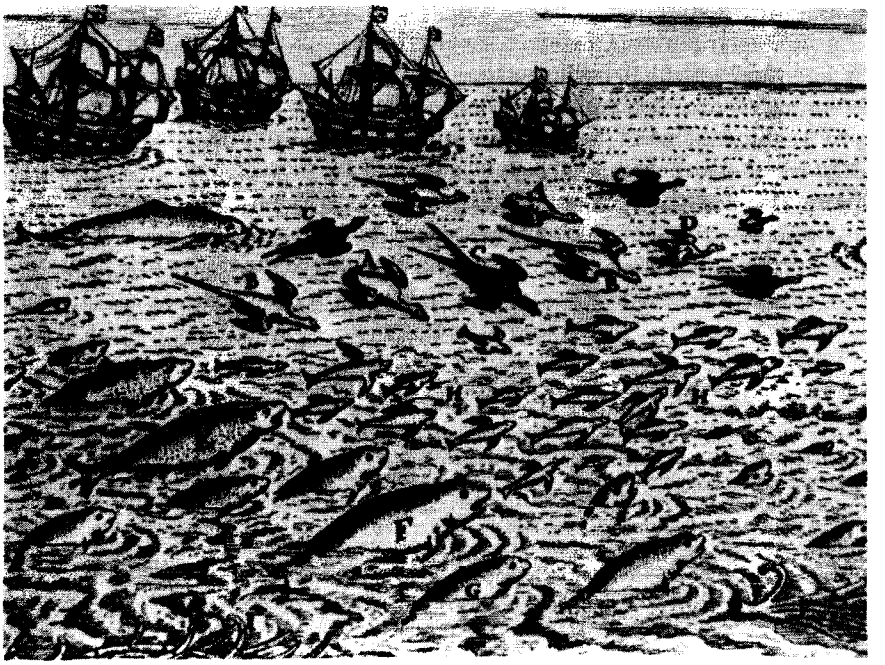


Figure 16. Drawing of several exotic fishes (dorado (E) and flying fish (H)) from the journals of the first voyage.

6. Epilogue

In this paper the background and content of the Dutch explorations of the southern sky have been extensively outlined to permit a discussion of the historical perspective in which these explorations should be placed.

At first sight one is inclined to connect the early mappings with a purely navigational tradition. Surely the demands of the ocean-going trade triggered off the scientific enterprises carried out during the first voyage. Moreover, some teachers in navigational astronomy at the turn of the sixteenth century claimed that sailors ought to be able to navigate on other stars than the so-called 'leading' stars.[64] This then would indeed imply the navigational necessity of a complete description of the southern sky. Yet, in the course of our study we have come to doubt that the Dutch explorations can be explained in this way.

From the scarce sources available at the end of the sixteenth century it is clear that the astronomical know-how among navigators was very limited. Books on navigation usually only mention the latitude of the Southern Cross.[65] Other descriptions of stars around the South Pole or of the Magellanic Clouds all lack a quantitative basis. Consequently, they cannot have had much application in navigation. For more than one-hundred years apparently neither the Portuguese nor other navigators felt the need for a better or more complete description of the stars around the South Pole, let alone a quantitative one. For practical purposes the simple knowledge of the latitude of the Southern Cross apparently sufficed. Stars other than leading ones clearly were *not* in demand at that time. One might argue that the navigational importance of a complete description of the southern celestial sky was a notion that only came into being at the end of the sixteenth century. If so, we still think this was rather a theoretical development maintained by some teachers than by the navigators themselves.[66]

This is borne out by the fact that very little use was made of the more precise knowledge acquired by the Dutch during their early voyages and published in the following decades in textbooks on navigational astronomy.[67] This lack of interest from navigational quarters indicates that the initiative of Petrus Plancius of exploring the southern sky must have gone far beyond the contemporary navigational needs of the ocean-going trade. It served first and foremost a purely scientific purpose, namely to fill the long-existing gap in our description of the complete heavens.

The scientific importance of the astronomical explorations is reflected by the readiness with which the new results were received in astronomical circles. Not only were the twelve new constellations of Plancius included in the famous stellar atlas by Bayer in 1603, even a catalogue was prepared by him in cooperation with Schiller and Bartsch, which was included as the third list in the 'Tabulae Rudolphinae' of Kepler in

[64] Burger (footnote 7), 100.

[65] M. Blundeville, *His exercises containing sixe treatises*... (London, 1594) is a good example. A series of data is discussed, but only the Southern Cross is considered useful.

[66] An extensive study on the reception of scientific knowledge in navigational quarters was recently published by C. A. Davids, *Zeewezen en wetenschap: de wetenschap en de ontwikkeling van de navigatietechniek in Nederland tussen 1585 en 1815* (Amsterdam, 1986).

[67] The most extensive account I found in Abraham Cabeliau, *Rekenkonst vande groote seevaert*... (Amsterdam, 1617). Of the ten stars south of the equinoctial line mentioned in the table preceding chapter 6, five were observed for the first time during the first voyage.

1627.[68] The completeness of the new description in the coverage of the sky and in the formation of constellations must have been crucial for the acceptance of the new data in astronomical circles.

The scientific character of the initiative of Petrus Plancius is further underlined by the fact that a connection between the new data and the earlier existing knowledge of the starry sky was made. This characteristic is already present in the work carried out by Plancius for the benefit of the celestial globe published by Van Langren in 1589. The result of a (presumably) first attempt to fit the rather scanty data on the stars around the south pole within the frame of the classical southern constellations, as seen on that globe, is typical for the state of knowledge at that time.[69] The difficulties encountered in his attempt might have motivated Plancius to carry out a complete survey of the southern sky. As such the globe published by Van Langren can be considered the predecessor of the globe published by Hondius of 1598, on which for the first time a full and correct description of the southern sky was presented. The differences between the two globes lies of course in the fact that only in the latter case reliable quantitative data were presented.

The scientific attitude of Dutch cartographers in the late sixteenth and the beginning of the seventeenth century appears to have been a crucial factor in the early explorations of the southern sky. Consequently, we believe that the astronomical explorations initiated by Plancius and followed up by De Houtman and Blaeu should be placed in the cartographic tradition that started with such important men as Mercator and Gemma Frisius, and that was instrumental in bringing about the general revival of scientific interest in the Low Countries from the middle of the sixteenth century onwards.

Placed in this perspective one can truly speak of the Dutch enterprise as the 'discovery' of the southern celestial sky, in spite of the fact that for generations it had been seen by so many Portuguese and other navigators.

[68] Johannes Bayer, *Uranometria*...(Augsburg, 1603), and Johannes Kepler, 'Tabulae Rudolphinae... (1627)', *in Gesammelte Werke*, 19 vols (Munich, 1937–1975) x, pp. 138–41. How in fact Bayer and Kepler came into possession of the data they published is the subject of Elly Dekker, 'On the Dispersal of Knowledge of the Southern Celestial Sky', *Der Globusfreund*, nos 35–37 (1987), 211–30.

[69] According to Blundeville (footnote 65), 222, Plancius himself had expressed doubts about the reliability of the constellations he introduced in 1589 and 1592.