Early Pole Star Tables

H. C. Freiesleben

(German Hydrographic Institute)

E. G. R. TAYLOR's interesting and noteworthy book *The Mathematical Practitioners of Tudor and Stuart England* shows that navigation was at first based on the experience of practitioners; men of science were too remote from practical requirements. There was a big gap between what interested them and what the seaman could understand and apply.

This state of affairs *appeared* to have changed at the beginning of the eighteenth century. Many astronomical books of the period deal with nautical problems. Primitive methods of position fixing, which had been important to the Great Age of Discovery, vanished and new methods, which required mathematical knowledge, were taught. What a lot of scientific questions are mentioned in books such as Maupertuis' *Astronomie nautique ou éléments d'Astronomie* (1756), and in other contemporary works. The method of Douwes' *Verhandeling om buiten den Middag op Zee de waare Middags-Breedte te vinden* (Harlem 1754) to determine latitude by ex-meridian observations of stars covers a great part in those books, so that one might be led to believe it had been of general use. On the other hand, the manuals of navigation do not say anything about the simple method of obtaining latitude by observing the Pole Star, which was so important at the beginning of the transoceanic sailings. The very old *Regimento do Norte* of Portuguese origin, presumably going back to the fifteenth century, teaches this method.[1] The compendium of Medinas' *Arte de Navegar*, often published and translated, gives diagrams showing how, from the positions of the 'guards', to correct an observed altitude to find the latitude (Fig. 1).

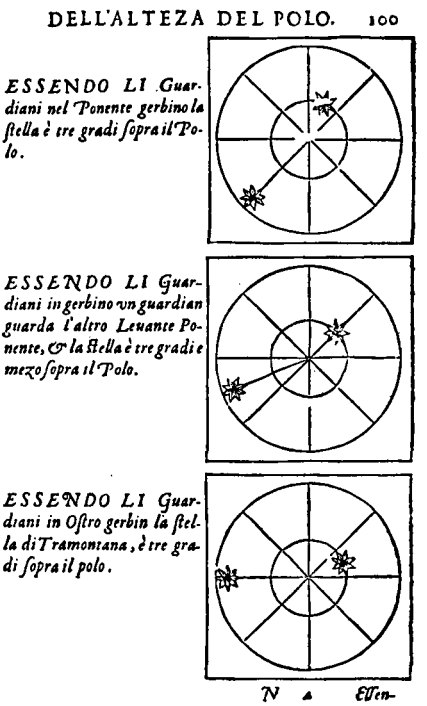

Fig. 1

It is incidentally interesting and confirms the opinions of E. G. R. Taylor of the estrangement between scientific doctrines and practical experience, to note that Nonius and the German cosmographers give the distance of *Polaris* from the

https://doi.org/10.1017/S0373463300016027 Published online by Cambridge University Press

Pole as 4° 9′, whereas the contemporary seamen [2] knew the correct value to be 3½°. Yet older are the rules for the determination of time at night by observation of the heavenly position of the 'guards', for which later on special instruments were introduced, the so-called Nocturnals. Nocturnals are not only for use with the 'guards', β and γ Ursae minoris, but also with the stars α and β Ursae majoris, a fact demonstrated by the inscription 'Both Bears' on many of the later instruments and the double indicator (Fig. 2). They are described in the compendiums of the sixteenth and seventeenth century, but in the eighteenth century they were hardly mentioned, although they were at the time well-known instruments, as Hewson points out.[3] They often carry engraved tables for reduction of the observed Pole-star altitude to obtain the latitude. Nic. Bion, Ingénieur du roi de France, and a thorough practitioner, also tells of the manufacture of nocturnals, which he would hardly have done had they had no market.[4]

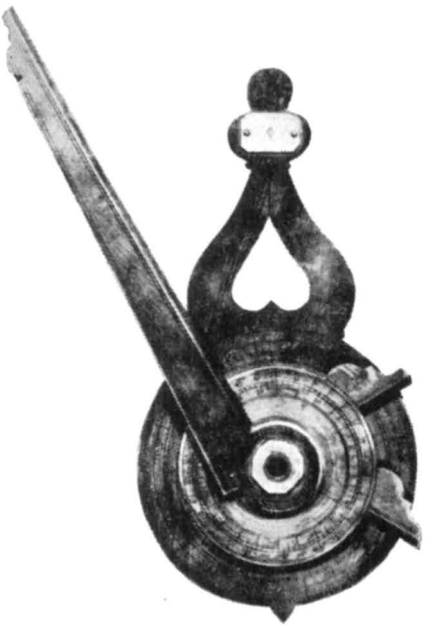

Fig. 2. The Nocturnal

So we can conclude that in the eighteenth century there was still a remarkable gap between scientific doctrine and practice. But we do not become aware of it immediately, because the scientific literature deceives us about the methods actually practised. The study of certain documents, however, reveals the truth. The library for instance of the German Hydrographic Institute possesses the manuscript of a scholar of a navigation school of about 1750. Obviously the instruction consisted in nothing but the calculation of examples, according to the rules given in the *Schat-Kamer ofte Konst der Stuurlieden* by Klaasz Hendricksz Gietermaker, the Dutch compendium, which was fourteen times published (from 1660 till 1774), a book very famous at this time and mentioned in the manuscript. As the edition of the book published at the time of our manuscript does not mention the Pole Star, there is no mention of it in the manuscript. We can conjecture that seamen, as a result of such instruction, compiled a large book with many examples of observation and calculation for all cases needed, probably without understanding the real sense.

An anecdote reported by Bouguer in his *Traité de Navigation* (1755) seems to bear this out. He tells of a captain who, when converting departure into difference of longitude by his *Quartier de rédùction*, probably a table for this purpose, always used the complement of the mean latitude and not the latitude itself. On his voyages between Europe and Canada, the average value of the latitude was 45°, so that he did not find out his mistake. Occasional faults in landfall he attributed to the incorrectness of his charts or to ocean currents. On a voyage to the Antilles his method naturally proved completely at fault. The

other navigators on board took great pains to clear up his error. 'Il s'imaginoit, qu'on ne lui parloit pas d'une manière sérieuse, ou qu'on vouloit le tromper', says Bouguer.

While scientific principles were being applied without judgment and even turned the wrong way, the seamen seem to have kept to their practical, primitive methods such as that of time and latitude finding by *Polaris*. Evidence for this was found in a letter, which the author accidentally came across when he was seeking the first Pole Star tables in the modern form, by means of which this star re-entered the scientific world and the manuals of navigation. Those tables are printed in the appendix of the *Ephemeris of the Four Planets* . . . &c., for the year 1822 (Copenhagen 1820). The author of the ephemeris, H. C. Schumacher, included the Pole Star tables at the request of the Danish Rear-Admiral Lovenorn, and Lovenorn transmitted the letter mentioned with a copy of the ephemeris to the Russian Admiralty at Petersburg. The admiral, in 1820 already advanced in years, writes amongst other things: 'Die als Anhang beigefügten Tabellen zur Berechnung der Breite durch Hülfe der Höhe des Polarsterns sind vollständiger als in den bisher erschienenen Navigationsbüchern. Ich sehe diese Observation von grösster Wichtigkeit an, und habe selbige sehr oft auf meinen Seereisen benutzt.' [The tables added as appendix for the calculation of latitude by means of the altitude of the Pole Star are more complete than those in the hitherto published navigation books. I regard this observation as most important, and I have used it very often on my voyages.] It is not clear which books Lovenorn means, as the known compendiums of his time did not contain Pole Star tables. Perhaps he refers to older works, of 1700 or so, but it is also possible that he means descriptions of Pole Star tables on nocturnals, and these tables are indeed much less complete.

So we may assume that the method of determining latitude by *Polaris* observations was always practised at sea, although it did not appear in the manuals of the eighteenth century. In the following century it was taken up by scientists, there being by that time a stronger requirement for accuracy, and improved for practice. The Pole Star tables were introduced into the *Nautical Almanac* in 1834, as a consequence of a resolution of 1830, altering the whole content of this work. The method is still used today in many almanacs.

It has even led to interesting extensions in our day. An example is the Star Altitude Curves of Weems, which contain curves for the Pole Star, though the star is not a very clear one; and in 1938 Fa. Carl Zeiss developed a special instrument, called 'Pol-Fernrohr' (Patentschrift 900 143 Kl. 42c 1953) which is similar to the ancient nocturnals in many respects. It contains a pane of glass, with two marks for the stars α and β Ursae minoris. If the instrument is pointed towards the North Pole of the heavens, and elevated according to the latitude, then, by setting the pane correctly on to the stars mentioned, it is possible to read off latitude and local sidereal time or, knowing G.M.T., the longitude of the place of observation.

These reflections perhaps confirm the views set out by D. J. Price[5] in his report about Professor Taylor's book, that the approach between seamen and scientists had its full effect only after 1800, when our technical age began. The reasons for this fact may perhaps best be seen in that change of mind which had its most explosive assertion in the great French revolution.

REFERENCES

1 Bensaude, J. (1912). *L'Astronomie Nautique au Portugal a l'époque des Grandes Découvertes*, Bern 1912, 223.

2 Wagner, H. (1918). Die Entwicklung der wissenschaftlichen Nautik, *Ann. Hydrogr., Berl.*, **46**, 217.

3 Hewson, J. B. (1951). *A History of the Practice of Navigation*, Glasgow, 1951, 117.

4 Bion, N. (1765). *Mathematische Werkschule*, 5th edition of the German translation, by J. G. Doppelmayr, Nürnberg, 415.

5 Price, D. J. (1955). The Mathematical Practitioners. This *Journal*, **8**, 12.

Professor E. G. R. Taylor comments:

As Dr. Freiesleben so clearly shows, the historian who takes current texts by distinguished authors as indicative of current practice, whether in navigation or in other fields, is liable to be seriously misled. Whereas down to the late eighteenth century it was the craftsman who lagged behind the scientist, today (according to a commonly voiced complaint) it is the manufacturer. The practical man, who has 'learned by doing' is understandably conservative and suspicious of change, while the modern business man is preoccupied with ways and means, with profit and loss, with avoidance of risk. And Dr. Freiesleben's example of the different figures for the polar distance of the Pole Star is instructive. Here the scientist was actually wrong. The faulty figure came from Johann Werner whose prestige as an actual pupil of the stupendous Regiomontanus led his fellows to accept it. The sailors had a better figure for the time being, yet in their ignorance they clung to it obstinately when, owing to precession, it had grown faulty too. They clung over long, too, to their familiar manuals, and the case cited of a Dutch compendium continually reprinted for more than a century has many parallels.

A small point of interest arising from Dr. Freiesleben's note is the fact that the Zeiss *Pol-Fernrohr* of 1938 had been anticipated in principle by that universal genius Robert Hooke (1636–1703). He had designed a telescope with the positions of two stars engraved on the object-glass so that when the images coincided with them the instrument was exactly on the meridian.