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(b. 1630; d. Paris, France, 1696)

Richer's birthplace, like the day and month of his birth and death, is unknown. His education is likewise shrouded in mystery. Yet when the Académie Royale des Sciences was organized, he was admitted in 1666 as an *aide* or *élève astronome*. When the Academy conceived the project of sending a skillful observer to a place far away from Paris in order to compare corresponding or simultaneous observations made at two widely separated stations, the scientist chosen for this task was Richer.

*astronomy, physics.*

According to the official financial accounts kept during the reign of [Louis XIV](#), a maker of mathematical instruments was paid on 5 April 1670 for supplying Richer with the technical devices he needed to carry out his instructions. Meanwhile he had arrived at [La Rochelle](#), on the Atlantic coast, where he measured the height of the tides in the harbor at the time of the [vernal equinox](#). Bad weather kept his ship from sailing until 1 May. Even then it did not get very far before a severe storm stopped both his marine pendulum clocks, which had been constructed at royal expense, and the reliability of which he had been expected to test. Crossing the [Atlantic Ocean](#), in July and August he observed the tides at two points on the coast of what was then French Canada (now part of [New England](#)). Presumably because he had a quadrant of the most recent design, equipped with cross hairs and with telescopic instead of open sights, he was able to determine the latitude of the French fort on Penobscot Bay in degrees, minutes, and seconds. Since previous determinations of latitude had been confined to the degree and the minute or, at best, the half-minute, Richer's was the most precise astronomical observation made up to that time anywhere in the western hemisphere.

On 17 September 1670 Richer was back in [La Rochelle](#), where he measured the tides at the autumnal equinox. He reported the results of his North American expedition to the Academy of Sciences early in January 1671. Although the Academy's manuscript minutes for this period have not survived, a portion of Richer's report can be reconstituted from a letter written by Huygens. No similar means are available for the reconstruction of the log of the ship on which Richer sailed, and most of his correspondence has likewise perished.

For instance, in a message to Huygens, which has been lost, Richer explained to the celebrated inventor of the pendulum clock why his instruments had failed. For his part Huygens, in a letter dated 4 February 1671, blamed Richer for not taking proper care of the clocks; not applying a bit of oil where needed; and not restarting the clock that had stopped, instead of waiting for the second one to stop too.<sup>1</sup> No competent horologist had been on shipboard with Richer. In *Horologium oscillatorium* (Paris, 1673) Huygens complained that "where success was lacking, this ought to be imputed to the carelessness of those to whom the clocks had been entrusted rather than to the devices themselves."<sup>2</sup>

Huygens' dissatisfaction with Richer's performance was evidently not shared by the French. For when the Academy of Sciences decided to send an expedition to Cayenne Island—off the coast of [French Guiana](#) and a little less than 5° north of the equator—once more Richer was selected. As early as 30 January 1670 he had been listed as a *mathématicien* "designated to go to Cayenne to make astronomical observations useful for navigation." To prepare for the paired observations to be made at Paris and Cayenne, in September and October 1671 Richer observed jointly with his counterpart who was to remain behind in Paris. Richer's expense money was provided on 27 September, and two days later his passport was issued; he "left Paris by order of the king [[Louis XIV](#)] in the year 1671 in the month of October."<sup>3</sup> His ship set; sail from La Rochelle on 8 February 1672<sup>4</sup> and on 22 April arrived at Cayenne. Richer remained there until 25 May 1673, when illness forced him to return to France earlier than he had planned.<sup>5</sup> After his departure his assistant died in Cayenne.

For unknown reasons, Richer was transferred from active service with the Academy of Sciences to fortifications and military construction with the title of *ingénieur du roi*. His written report on his South American expedition, "Observations astronomiques et physiques faites en l'isle de Caïenne," was published in the *Mémoires* of the Academy, of which he was designated a full-fledged member (*académicien*) in 1679. Thereafter, no information about him exists except that he died in Paris in 1696.

It was the publication of Richer's "Observations" that saved him from utter oblivion, for his South American report provided the basis for momentous conclusions concerning the earth and the other members of the [solar system](#). He put the longitude of his primitive Cayenne observatory, built in the native style, "about 3 hours, 38 minutes, west of the Paris Observatory,"<sup>6</sup> only some three minutes in excess of the modern figure. From Richer's observations in 1672 of the eclipse of the moon on 7

November and of a satellite of Jupiter on 1 April, the difference in longitude between Paris and Cayenne was placed within fairly close range of the correct value.<sup>7</sup>

The near precision permitted the reliable reduction to the Paris meridian of Richer's observations of Mars. "During the months of August, September, October, and November in 1672 ... the path of this planet was quite extraordinary,"<sup>8</sup> Mars being then in its perigee. A comparison of Richer's observations of perigean Mars with corresponding observations made elsewhere, yielded a reasonable value for the parallax of this planet and in turn for the parallax of the sun. From this calculation was derived a fairly close approximation of the fundamental [astronomical unit](#), the distance from the sun to the earth. The dimensions of the [solar system](#) and of its constituent bodies were thus disclosed for the first time with substantial accuracy.

In addition to this dramatic enlargement of the size of the cosmos as traditionally conceived, Richer's physical observations led to an improved understanding of the shape of the earth. Among the numerous purposes for which the Academy had resolved to dispatch an observer to a location near the equator was the desire to acquire more definite knowledge about "the length of the seconds pendulum in this same place."<sup>9</sup> A pendulum requiring exactly one second for each swing in either direction turned out to be an immensely valuable research tool. In the report Richer said:

One of the most important observations I have made is that of the length of the seconds pendulum, which has been found shorter in Cayenne than at Paris. For the same measurement marked on an iron rod in the former place in accordance with the length found necessary to make a seconds pendulum was transported to France and compared with the Paris measurement. The difference between them was found to be 1 1/4 lines, by which the Cayenne measurement falls short of the Paris measurement, which is 3 feet, 83/5 lines [1 line = 1/144 foot = 21/4 millimeters]. This observation was repeated during ten whole months, when no work passed without its being carefully performed several times. The vibrations of the simple pendulum which was used were very short and remained quite perceptible up to 52 minutes, and were compared with those of an extremely good clock whose vibrations indicated seconds.<sup>10</sup>

For the measurement of time I had two pendulum clocks, one of which indicated seconds and the other half-seconds. They had been made by the ... king's regular watchmaker who, by his precision and the refinement of his products, has up to the present surpassed all those who are busy making watches and pendulum clocks.<sup>11</sup>

Isaac Newton wrote in the *Principia*:

Now several astronomers, sent into remote countries to make astronomical observations, have found that pendulum clocks do accordingly move slower near the equator than in our climates. And, first of all, in the year 1672, M. *Richer* took notice of it in the island of *Cayenne*; for when, in the month of *August*, he was observing the transits of the fixed stars over the meridian, he found his clock to go slower than it ought in respect of the mean motion of the sun at the rate of 2<sup>m</sup>.28<sup>s</sup>. a day.<sup>12</sup>

Richer's empirical discovery that a pendulum keeping perfect time in Paris had to be shortened near the equator if the clock was to beat seconds there required a rational explanation. "The conclusion was ... that the same pendulum moved more slowly at Cayenne than at Paris; consequently the effect of gravity was less at the equator than in our region ... Therefore the earth must be higher at the equator than at the poles. Hence the earth is a spheroid flattened at the poles."<sup>13</sup> In this impressive chain of reasoning the first link was supplied by Richer as he patiently watched his pendulum clock in Cayenne Island.

## NOTES

1. *Oeuvres complètes de Christiaan Huygens*, VII (The Hague, 1888–1950), 54–55.

2. *Ibid.*, XVIII, 116–117.

3. Richer, *Observations*, ch. 1 (repr., Paris, 1729), 235.

4. Not 6 February 1672, as in Alfred Lacroix, *Figures de savants*, III (Paris, 1938), 12.

5. J.-D. Cassini, *Éléments* (repr., Paris, 1730), 72.

6. Richer, *Observations*, ch. 2 (1729), 237–238.

7. Cassini, *Éléments* (1730), 69.

8. Richer, *Observations*, ch. 9 (1729), 278.

9. *Ibid.*, ch. 1, p. 235.

10. *Ibid.*, ch. 10, art. 1, p. 320.

11. *Ibid.*, ch, 2, p. 236.

12. Newton, *Principia*, bk. III, prop. 20.

13. D'Alembert, "Figure de la terre," in *Encyclopédie*.

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See "Observations astronomiques et physiques faites en l'isle de Caiennae," in *Mémoires de l'Académie royale des sciences depuis 1666 jusqu'à 1699*, VII, pt. 1 (Paris, 1679), 231–326.

On Richer and his work, see J.-D. Cassini, "Les élemens de l'astronomie verifiez par Monsieur [Jean-Dominic] Cassini par le rapport de ses tables aux observations de M. Richer faites en lisle de Cayenne," in *Mémoires de l'Académie royale des sciences depuis 1666 jusqu'à 1699*, 8 (repr., Paris, 1730), 53–117; Alfred Lacroix, *Figures de savants*, III (Paris, 1938), 11–14; John W. Olmsted, "The Scientific Expedition of John Richer to Cayenne (1672–1673)," in *Isis*, 34 (1942–1943), 117–128; and "The Voyage of Jean Richer to Acadia in 1670," in *Proceedings of the American Philosophical Society*, 104 (1960), 612–634. See also *Index biographique des membres et correspondants de l'Académie des sciences do 22 décembre 1666 au 15 décembre 1967* (Paris, 1968), 468.

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