

THE TRACK OF THE COLUMBUS CARAVELS IN 1492

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Attempts have been made to map the probable track of the Columbus caravels on the cruise of 1492 which resulted in the discovery of the Western Hemisphere within the West Indian region. The most elaborate of these is by Professor Samuel Eliot Morison of Harvard University and of the Harvard-Columbus Expedition of 1939.¹

Professor Morison and the others who have attempted to map the track of the caravels have considered that the Admiral's compasses pointed to the true north, and that when he steered his ships due west by compass, they sailed in that direction. As we know today, the magnetic compass points not to the North Pole, but to the magnetic North Pole, which is located in Arctic Canada more than a thousand miles south of the geographic North Pole. The angle by which the compass varies from pointing to the true Pole is different in different parts of the world, and for the seas, it is only within the present century that a chart with approximately reliable values has been available.

In what follows we have introduced these corrections to the compass bearings set down by Columbus in his log, and have been able to show that instead of sailing directly through the North Temperate Zone to his American landfall at San Salvador, the caravels entered at once upon a course west-southwest which brought them into the Tropics; and that they continued the voyage largely within the North Tropical Zone of Calms. This continued until they had skirted the islands of the Lesser Antilles, but now on a northwesterly course before emerging from the Tropics only a few hundred miles to the east of San Salvador.

On this course the crews had for much of the way sighted birds in flight which are not to be found except within the Tropics, and the caravels had skirted the southern border of the Sargasso Sea where it invades the Torrid Zone. Here they had been becalmed in the Belt of Tropical Calms for 17 days of the 35 of the voyage. Soft breezes and ocean currents, always from behind them, had carried them on to their fateful landfall.

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¹ *Admiral of the Ocean Sea* (2 vols., Boston, Little, Brown and Co., 1942). See especially Vol. I, map opposite p. 294. There is a one volume edition with the same title, the pertinent part of which is chapters xii-xvi and the map opposite p. 222.

The only source for preparing a map of the track of the caravels is the Columbus journal.² Columbus sailed from Gomera Island near Tenerife on September 6, 1492. He carried as his navigational instrument compasses of an early pivotal type. Instruments to measure the angular elevation of the heavenly bodies (cross staff, quadrant, etc.) did not come into use to obtain latitude at sea until the 16th century,³ and longitudes over the ocean were first determined on shipboard after William Harrison had perfected his chronometer in 1759.⁴ Until both latitude and longitude could be measured on the deck of a vessel, it was not possible to chart the variation of the compass over the seas of the world.

Before the compass had come into use, navigators could use the direction of *Polaris*, if visible at night, though they seldom sailed after dark. That there was sometimes a lack of correspondence between the pointing of the compass needle and the bearing of the North Star was first noted by Columbus himself on this historical voyage, but he attributed this to a motion of the star.⁵

Long before compass variation could be determined over the

² *The Journal of Christopher Columbus (During his First Voyage, 1492-93) and Documents Relating to the Voyages of John Cabot and Gaspar Corte Real*. Translated, with notes and an introduction, by Clements R. Markham, C.B., F.R.S., President of the Hakluyt Society (London, 1893, Hakluyt Society Publication No. LXXXVI). The portion of this journal which refers to the westward voyage from the Canary Islands to the land-fall on San Salvador is on pages 15-38. Markham's account is taken from the Las Casas record (since the Columbus original was lost). In Ferdinand Columbus' life of the admiral, his father, published at Venice in 1571, there is a briefer abstract of the journal, which is in close agreement, but adds some data on the winds and on birds seen.

³ See Abbé Albert Anthiamme, *Recherches sur l'Histoire de la Science Nautique antérieure à la découverte du Nouveau Monde* (Société Havraise d'Etudes diverses. Extrait du Recueil de ses Publications) (Le Havre, H. Micaux, 1913).

⁴ See Lloyd A. Brown, *The Story of Maps* (Boston, Little Brown and Co., 1949), chapter viii.

⁵ On September 13, 17 and 30 he noted a considerable lack of correspondence at night-fall, but the needles again pointed true just before the dawn the next morning. It is now known that on those dates *Polaris* and the "Guardians" of the "Little Dipper" were close to his horizon, so that the differences of azimuth were easily measured. From *Polaris* it amounted to a half point on the 13th, and to a full point ($11\frac{1}{4}^\circ$) on the 17th and 30th. In attributing this to motion of *Polaris*, Columbus was partly right. Its orbital radius, now 58' of arc, was then 3°30'. The other 7°(W) on the later dates was due, if his measurements were accurate, to a west declination of his compass, which now measures 20°W at those localities. Had his course been due west from Gomera he would have been in lat. 29°W and *Polaris* would have been too high in the heavens for him to detect the discrepancy. For some of this data I am indebted to Carl A. Bauer of the Astronomy staff of the University of Michigan.

sea, its distribution over the land areas (where clocks gave a fair measurement of the lapse of time) was measured, and by extrapolation some charts were constructed. As far back as 1530 Alonzo de Santa Cruz issued such a chart. In 1700 Edmund Halley, Astronomer Royal of England, published a chart "shewing the variations of the compass in the Western and Southern Oceans as observed in ye Year 1700 by their Ma^{ties} Command by Edm. Halley." In 1692 from observations made in the land areas Halley had been able to show that compass variation changed with time.⁶ Another who issued an early chart of the supposed distribution of compass variation over the Atlantic Ocean between latitudes 5° and 50° N was Bellin.⁷ These charts had all made their appearance long after Columbus, and the figures given had little value.

Reliable values for compass variation over the seas date from the present century, and especially from observations made on the yacht *Carnegie* of the Division of Terrestrial Magnetism of the Carnegie Institution of Washington. These date from 1909 and later. Repetitions of the observations after a short lapse of time have been the basis of isogons giving the supposed annual rate of change of variation. Within the region of the Columbus voyage these are given as varying from -5' (E) to +5' (W).⁸ Since it is our aim to use the compass variation of 1492, we must examine the behavior of the earth's North Magnetic Pole since it was discovered in the early nineteenth century.

When first visited by the English explorer James Clark Ross in June, 1831, the Pole was located on Boothia Peninsula in latitude 70° 5' N, longitude 96° 46' W (Fig. 1). When next visited, this time by the Norwegian explorer Roald Amundsen in the *Giöa* on May 3, 1904, the Pole was found to have moved forty nautical miles northeast of its earlier position and was in latitude 70° 30' N, longitude 95° 30' W. It was not again visited until 1947, this time in an airplane by Serson and Clark, geophysicists of the Division of Terrestrial Magnetism of the Dominion of Canada. The Pole had now moved to a new position, and was in northwest Prince of Wales Island in latitude 73° N,

⁶ "On the cause of the change in the variation of the magnetic needle; with a hypothesis of the structure of the internal parts of the earth," *Philosophical Transactions, Royal Society of London*, XVII (1692) 470-478.

⁷ *Carte des Variations de la Boussole*, 1765. (In Clements Library.)

⁸ *The Variation of the Compass for the Year 1945*. (H. O. Chart 1706. Formerly 2406) Published at the Hydrographic Office under the authority of the Secretary of the Navy (Washington, D. C., First edition; September, 1946).

longitude 100° W, a point 150 miles north northwest of its position when first discovered.⁹



Fig. 1. Map of the area about the North Magnetic Pole in Arctic Canada showing its orbital movement.

The three positions of the Pole already observed allow us to construct its orbit, which has a radius of about 85 miles. The angular distances travelled between 1831 and 1904 (16 degrees of arc in 73 years) and between 1904 and 1947 (120° in 43 years), indicate by their lack of correspondence that the earlier movement includes one or more complete orbital cycles. The period of the cycle is in all probability 129 years, and a change of sign of the change would occur every 65 years. Between 1492 and 1946 (453 years) there have been almost exactly seven half-cycles of 65 years. Hence the compass variations in 1492 along the course of the Columbus voyage should vary little from present values.

⁹ Glenn Madill, "The search for the North Magnetic Pole," *Arctic* (Journal of the Arctic Institute of North America), I (No. 1, Spring, 1948), 8-18, illustrated.

Before plotting the track of the caravels, it is well to abstract from the twenty-four pages of the Columbus journal the statements which relate to his log or to observations which help to map the course. The corrected compass directions and other comments are inserted in brackets. The Columbus league is 3.18 sea miles (see the map of Figure 2).

- Sept. 6. Departed from Gomera. Calm all day.
- Sept. 7. Calm all day.
- Sept. 8. Calm until third hour of the night, when it blew from NE. Course W [W 15° S]. Took much sea over the bows. Made an estimated 29 miles.
- Sept. 9. Sailors steered badly. Ships fell off to NE [N 30° E]. Made 156 miles. [From Gomera 185 m.]
- Sept. 10. Made 191 miles. [From Gomera 376 m.]
- Sept. 11. "Sailed on their course which was west" [W 20° S]. Made over 127 m. [From Gomera 503 m.]
- Sept. 12. "Steering their course" [W 20° S]. Made 105 m. [From Gomera 608 m.]
- Sept. 13. "Steering their course, which was west" [W 20° S]. Made 105 m. [From Gomera 713 m.]
- Sept. 14. "Navigated on their westerly course." Made 64 m. [From Gomera 777 m.]
- Sept. 15. "On their west course." [W 20° S] and made 86 m. [From Gomera 863 m. In Ferdinand's account the wind was from the NE and the current as well.]
- Sept. 16. Steered their course west [W 20° S]. Made 124 m. [From Gomera 987 m.] "The Admiral says that on that day and ever afterwards they met with very temperate breezes." Many tufts of grass. [Gulfweed off southeastern border of the Sargasso Sea, see Fig. 2.]
- Sept. 17. "On their west course" [W 20° S] and made over 159 m. [From Gomera 1146 m.] "Aided by the current." Much weed which came from the west and enclosed a live crab. The sea water less salt. "Breezes always soft." Saw many tunny [tuna] fish [found in most tropic seas]. Saw a boatswain bird [found only in the tropics].
- Sept. 18. In all these days the sea was very smooth like the river at Seville. Made over 175 m. [From Gomera 1321 m.] Multitude of birds flying westward [from breeding grounds in Cape Verde Islands to their fish prey in ocean current].

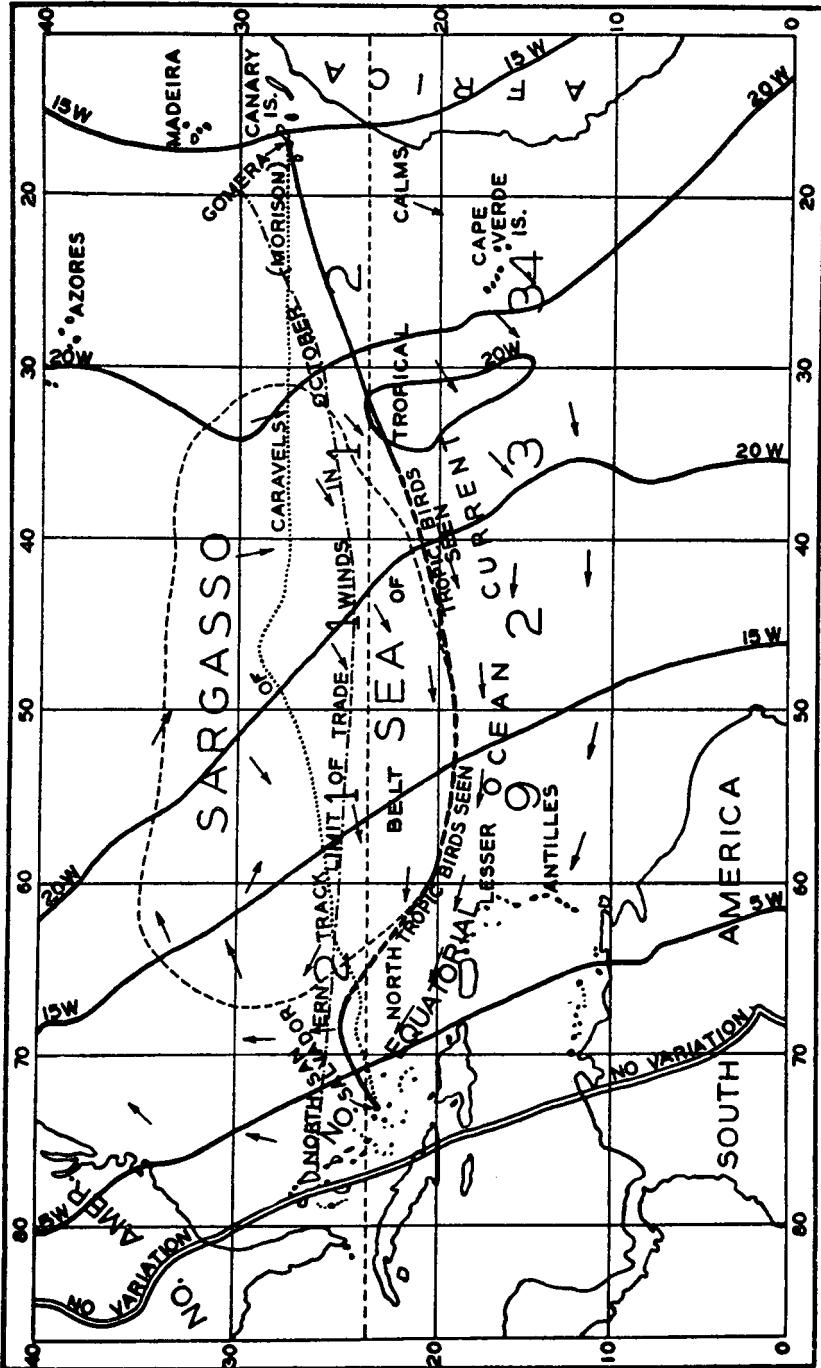


Fig. 2. Map to show the probable track of the Columbus caravels from Gomera, Canary Islands, to Guanahani (San Salvador or Watlings Island, West Indies). The isogons of compass variation in 1945 are the heavy lines. (From *H. O. Chart 1706*, Navy Department.) The arrows show the direction of ocean currents and of prevailing winds for the month of October (from *H. O. Pilot Chart 1400*). The large figures indicate the relative number of oceanic birds usually seen in flight in these 10° squares. (From a map by P. Jespersen, *On the frequency of birds over the High Atlantic Ocean.*) See note 14 below.

- Sept. 19. "Admiral continued on his course" [W 18° S]. Made but 80 m. because calm. [From Gomera 1401 m.] A booby [*Alcatraz*] came to the ship and in the afternoon another. Weather fine with little wind. [The booby is found only in the tropics.]
- Sept. 20. This day the course was W by N and all round the compass because of calm. Made only 22 m. [From Gomera 1423 m.] "Two boobies came to the ship and afterwards another." Saw much gulfweed though none seen the day before. [Hence have entered the south border of the Sargasso Sea.] Caught a tern [a tropic bird, though the arctic and some other types range far outside]. "At dawn two or three land-birds came singing to the ship, and they disappeared before sunset." "Afterwards a booby came from W N W [W 4° N]; for these birds sleep on shore and go to sea in the mornings in search of food." [A quite correct statement, here from the Cape Verde Islands to the east southeast, the greatest breeding place of oceanic birds in the North Atlantic south of the 40th Parallel. See figures on Fig. 2 for numbers of birds seen flying daily in each 10° square.]
- Sept. 21. Most of the day calm. Later a little wind. Made only 41 m. [From Gomera 1464 m.] The sea covered with gulfweed [in the Sargasso Sea]. A booby seen. Sea very smooth and "air the best in the world". Whale seen.
- Sept. 22. "Shaped course W N W more or less" [W 8° N]. Her head turning from one point to another and made only 95 m. From Gomera 1559 m. "Saw some sandpipers" [the sandpiper is not a pelagic bird, probably the golden plover or a phalarope related to the sandpiper¹⁰]. Part of the day no weed, later it was very thick [still just outside southern border of Sargasso Sea].
- Sept. 23. Still without good steerage way, though the intended course was west. Made only 70 m. [From Gomera 1629 m.] Saw a dove, a booby, "another river-bird and some white birds." Much gulfweed with crabs in it. Sea smooth and calm. "Afterwards the sea rose very much without wind which astonished them."

¹⁰ In the original the word is *pardelas*. Dr. Alexander Wetmore, of the Smithsonian Institution identifies this as a web-footed bird resembling a gull.

- [They were probably drifting in the wake of one of the West India hurricanes which are prevalent in this region in September.]
- Sept. 24. Calm continues. Made only 45 m. [From Gomera 1674 m.] A bocby came to the ship and many "sandpipers."
- Sept. 25. Day began with calm, but afterwards there was a wind. Until night on west course [W 10° S]. The first false alarm of land seen. The course was altered to the SW [W 55° S]. Made 13 miles on "west" course and 54 on "SW" course. Made 67 m. [From Gomera 1741 m.] Sea very smooth. Sailors bathed. Many fish seen. [Since the 18th, seven days, the caravels have been becalmed in the North Tropical Belt of Calms, and this was to continue for another six days.]
- Sept. 26. Calm continues with sea like a river. Made 99 m. [From Gomera 1840 m.]
- Sept. 27. Course W [W 10° S]. Made 76 m. [From Gomera 1916 m.] "Many dories (*dorados*) came" and one was killed. Boatswain bird came.
- Sept. 28. Calms. Made 45 m. [From Gomera 1961 m.]
- Sept. 29. Calms continue. Made 76 miles on course. [From Gomera 2037 m.] Frigate bird seen and two boobies. Later three boobies and a frigate bird [all these are tropical birds]. Much gulfweed.
- Sept. 30. Calms continue. Made 45 m. [From Gomera 2082 m.] Four boatswain birds came to the ship. Saw also four boobies. Much weed.
- Oct. 1. Heavy rain shower. Course west [W 10° S]. Made 80 m. [From Gomera 2162 m. Columbus records on this date his distance from Gomera as 2248 m.]
- Oct. 2. Course west [W 10° S] but for many days in calms and very light winds the caravels have been drifting in the North Equatorial Current which here flows W N W. Made 124 miles. [From Gomera 2286 m.] Sea smooth. Weed coming from the east to the west. [This is the regular clock-wise rotation of the eddy of the Sargasso Sea on its southern border.]
- Oct. 3. On usual course made good 149 m. [From Gomera 2435 m.] Much gulfweed and many birds described as "sandpipers".
- Oct. 4. Course west [W 10° S]. Made 200 m. [From Gomera 2635 m.] More than 20 sandpipers [plover] came to

the ship in a flock and 2 boobies, a frigate bird "and a white bird like a gull".

- Oct. 5. Admiral steered his course and made 181 m. [From Gomera 2816 m.] Wind increased somewhat during the night. Sea smooth and quiet. No weed, hence out of Sargasso Sea. Many flying fish [especially prevalent in warm seas] coming on deck and many "sandpipers" seen.
- Oct. 6. Continued west course [W 5° S]. Made 127 m. [From Gomera 2943 m.]
- Oct. 7. West course [W 5° S] continued. Made 73 m. [From Gomera 3016 m.] Land reported to the west southwest from the *Niña* at sunrise. [This was very likely Puerto Rico or one of the Virgin Islands, which must have been in that direction.] No land seen in the afternoon, but they passed a great number of birds flying from N to SW. [This was doubtless the usual October southward migration of birds from Labrador, Nova Scotia and Bermuda to South America.] An hour before sunset altered course to W S W [W 27° S] and made 16 miles more. Made for the day as a whole 89 m. [From Gomera 3032 m.]
- Oct. 8. Course W S W [W 27° S]. Sea very smooth. Many land birds. Terns, ducks and a booby seen. Made 38 m. [From Gomera 3070 m. In Ferdinand's account a jay was seen and many other birds, all flying towards the southwest.]
- Oct. 9. Course SW [W 50° S]. The wind then changed and steered W by N [W 16° N]. Made 100 m. [From Gomera 3170 m.] Birds were heard passing overhead throughout the night [the autumn migration southward].
- Oct. 10. Course was W S W [W 28° S]. Made 188 m. [From Gomera 3358 m.] At ten at night the Admiral saw a light.
- Oct. 11. Course W S W [W 28° S]. There was more sea than at any time during the voyage [perhaps the ground swell as they neared land]. Saw "sandpipers". Until sunset the run was 83 m. At sunset changed steering to original W [W 5° S] course, and until midnight, when land was seen, had made 72 [or 90] m. [From Gomera 3513 miles.] At two hours after midnight the land was

seen at six miles distance. The ships hove to and they waited for daylight.

Oct. 12. Landed at island of Indian name Guanahani, named by Columbus San Salvador, and now Watlings Island.

If we except a single statement made at the start of this log, Columbus does not refer to the direction of the wind. This is remarkable, for if the wind had at any time been contrary, and he had been compelled to tack, it would almost certainly have been recorded. The track of his caravels as plotted on the map of Figure 2 shows that he was at all times south of the northern limit of the trade winds, and that winds and currents alike for the autumn months take the course which he followed.¹¹

For about one-half of the voyage the Columbus caravels had sufficient wind to obey the helm and keep the course which he steered (18 days with an average daily run of 128 m., or 5½ knots). This part of the voyage is plotted on the map of Figure 2 by a full line. Soon after entering the North Tropical Belt of Calms, however, the wind fell off and calms prevailed, so that the ships lost steerage way to drift in the westwardly directed ocean current of the North Tropical Zone. The average daily run for these 17 days of "calm" is 65 m., or 2¾ knots. This figure indicates that "the soft breezes" which accompanied the calms added their effect to that of the current. The caravels had a high freeboard with relatively lofty "castles" at both prow and stern, which would "take" the following wind more than would the flapping sails. These winds (and the currents) to the eastward of longitude 40° W, blow from the northeast, between 40° and 45° W they come from the east, and west of 45° from the southeast (Fig. 2).

That Columbus was in the tropics is confirmed by the ocean birds which he saw in flight, since these birds are all found in the North Tropical Zone, and most types seen (frigate or man-o'-war bird, booby, and "bo'sun" or tropic bird) never range north of the Tropic of Cancer. The terns seen also, if of the sooty variety, have the same restricted range.¹² The numbers of the birds which Columbus sighted are also significant in fixing his position, for such numbers vary greatly in different parts of the North Atlantic, and they can be used by shipwrecked persons

¹¹ *Pilot Chart for the North Atlantic Ocean for October, 1945* (H.O. No. 1400). See also *Pilot Chart of the Central American Waters for October, 1945* (H.O. Chart No. 3500). Issued by the Department of the Navy.

¹² I am indebted to Dr. Josselyn Van Tyne and Dr. Alexander Wetmore for information on pelagic birds.

drifting in boats or rafts in order to fix their position and that of the nearest islands (the birds' breeding places,¹³ for they seldom, if ever, nest on the continental coasts). Their flight direction during the late afternoon is toward their island breeding grounds. Two important Danish expeditions lasting over several years have determined the relative numbers of birds seen daily in flight from points within the different ten-degree squares of the North Atlantic, also the bird varieties.¹⁴ These relative numbers after Jespersen I have given for each of the pertinent squares on the map of Figure 2. It will be noted that the two areas within which Columbus sighted birds are close to the two squares which take respectively first and second place for the number of birds sighted. The Sargasso Sea, and the ocean throughout along the Morison track of the caravels, is for birds the most barren area in the entire North Atlantic. This route is moreover throughout in the North Temperate Zone with the contrary winds and currents of the prevailing westerlies.

Another apparent confirmation of the general correctness of the track laid down on the map of Figure 2 is its relation to the Sargasso Sea. The Columbus log rather clearly indicates that he was skirting its southern border. On one day he would report gulfweed, the next day perhaps none, and so was in and out of its marginal area. Had he invaded the sea for any considerable distance, he would have been surrounded by weed, and the birds would all have deserted him. These birds need to espy the fish from above and dive for them. Ornithologists seem to believe that the weed masks their prey, and for this reason the birds fish in more favorable regions.

The track here traced was laid out on a standard 18-inch globe and found to have a length of 3430 miles, to compare with the 3513 mi. of the Columbus dead reckoning. The length of the Morison track (3066 m.) approaches the intentionally false estimate which Columbus gave to his sailors, a figure as low as he thought he could make them believe.

¹³ Harold Gatty, *The Raft Book, lore of the sea and sky* (New York, George Grady Press, 1943, 152 pp., illustrated).

¹⁴ P. Jespersen, "On the frequency of birds over the High Atlantic Ocean," *Verhandlungen des VI International Ornithologen Kongresses in Kopenhagen, 1928* (Berlin, February, 1929), pp. 163-172, 5 maps. See also V. C. Wynne-Edwards, "On the habits and distribution of birds on the North Atlantic," *Proceedings, Boston Society of Natural History*, XL (No. 4) 233-346, pls. 3-5.