

XVI. *Magnetical Observations made in the West Indies, on the North Coast of Brazil and North America, in the Years 1834, 1835, 1836, and 1837, by Captain Sir EVERARD HOME, Bart. R.N. F.R.S. Reduced by the Rev. GEORGE FISHER, M.A. F.R.S.*

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IT was the object in the experiments recorded in this paper, to determine the relative magnetic forces soliciting both the dipping, and horizontal needles, by observing the times of their completing a given number of vibrations at the various places visited during a period of three years, on the North American and West India Station, in Her Majesty's Ship *Racehorse*.

The dipping instrument used was one of modern construction by DOLLOND. Each observation for the dip consisted of an equal number of readings of the positions of the needle, with the face of the instrument east and west, before and after the inversion of the poles, and a mean of all the readings taken for the true dip. The instrument had two needles fitted to it, one of which being used solely for the purpose of observing its vibrations, its magnetism was therefore never interfered with, and this needle in this paper is distinguished by the letter B. The other needle was kept for the purpose of determining the dip, and the results obtained with it are given in Table I.

For the purpose of determining the horizontal forces, besides the needle B, four other needles, Nos. 1, 2, 3, and 4, were used, the first two, four and a half, the others, three inches in length, and of a cylindrical form. When used they were suspended by fibres of raw silk in an apparatus constructed for the purpose. They had fixed centres of suspension, with sliding weights for their horizontal adjustments. The vibrations were confined to the same limits of arc, so as to render the experiments as comparative as possible, and to avoid any correction for circular arc. The state of the thermometer was also registered, though at present it is impossible to assign with any degree of accuracy the correction due to the results arising from the differences of temperatures at which the experiments were made.

The needles Nos. 1, 2, 3, and 4 appear, by comparing the experiments made near London previous to the voyage, with similar ones at the same place at the expiration of it, to have lost during the interval some portion of their magnetism; the same circumstance is also observable from the experiments made at Bermuda and other places. To compensate for this change in the intensities of the needles, the experiments contained within the horizontal lines in the Tables in which they are recorded

have been reduced to the same epoch, or mean period of observation, by the application of a proportional part of this change; and the corrected or concluded times of completing a given number of vibrations for each needle, together with the corresponding forces, which are inversely as the squares of these times, are given in separate columns. These forces are again reduced, and compared with the horizontal force at Plymouth, which is taken equal to unity.

The magnetism of the needle B appears to have been subject to some occasional changes during the voyage, but not of sufficient magnitude or regularity as to admit of any correction being made on this account. The mean of all the experiments collectively, that were made at the same place with this needle, is therefore taken as one result, and compared with others obtained in a similar way at the other places.

Some degree of uncertainty is attached to experiments of this nature when made with various needles, the whole of which have only been occasionally used, and the magnetism of these subject to various changes, on account of the difficulty of assigning such values for the final results as the experiments themselves seem best to justify, since the means as deduced from the experiments at each place are on this account somewhat vitiated, being no longer *strictly* comparative; and moreover the same experiments may by different persons be differently compared with each other, and thereby results somewhat different may be obtained.

It is necessary to state, therefore, that the horizontal forces at Plymouth, Bermuda, and Port Royal in Jamaica have been determined by the experiments made at Plymouth in March 1834, immediately before leaving England, compared with similar ones made at the two latter places in the months of June and July following, and by applying a small correction for the diminution in the intensities of the respective needles. The experiments at Chagres are compared with the previous and subsequent ones at Jamaica made at short intervals of times; those at Parà, Maranham, and Demerara with those made at Bermuda; and lastly those at Antigua with the previous and subsequent ones at Bermuda. The experiments thus grouped and compared together are contained between the horizontal lines in the Tables II., III., IV., and V., together with the comparative horizontal forces between these places; these forces are then compared with the force at Plymouth, and the results given in a separate column.

Having thus obtained the horizontal forces at each place as compared with Plymouth, these are again reduced to the forces in the direction of the dipping needle by multiplying the horizontal forces by the fraction $\frac{\cos. \text{dip at Plymouth}}{\cos. \text{dip at Place}}$. The comparative whole forces being deduced by means of the horizontal needles, and also by direct experiment with needle B when vibrated in the dipping instrument, the final results are given in Table VIII.

TABLE I.

Containing the Dip as observed at different places.

Dates.	Places.	Lat.	Long.	Dip.	Remarks.
1833. July 20 and 29.	Near London ..	51° 26' N.	0° 18' W.	69° 52' 38"	Observations made at Ham, near London.
1834. Jan. 4.	"	"	"	70° 17' 42"	Observations made at the same place.
Mar. 3.	Plymouth	50° 22'	4° 9'	69° 58' 2"	At the Athenæum.
11.	"	"	"	69° 56' 20"	
April 2.	"	50° 20'	4° 7'	69° 44' 54"	On the Breakwater (in the centre).
9.	"	"	"	69° 41' 10"	
May 27.	Halifax	44° 39'	63° 37'	75° 33' 1"	At the Observatory in the Dockyard.
June 11.	Bermuda	32° 18'	64° 50'	67° 46' 21"	In the Dockyard.
16.	"	"	"	67° 44' 12"	
July 11.	Jamaica	17° 55'	76° 50'	47° 0' 42"	On the Point at Port Royal.
11.	"	"	"	47° 5' 7"	"
Aug. 1.	"	"	"	47° 4' 41"	"
Sept. 11.	Nicaragua	10° 58'	83° 43'	34° 2' 54"	Point Arenas.
12.	"	"	"	34° 7' 42"	
18.	Chagres	9° 20'	80° 1'	32° 36' 4"	Castle of St. Lorenzo (on the platform).
18.	"	"	"	32° 31' 5"	
19.	"	"	"	32° 23' 26"	
30.	Jamaica	17° 55'	76° 50'	46° 49' 16"	Port Royal Point.
Oct. 6.	"	"	"	47° 6' 40"	
1835. Feb. 6.	Alta Vela	17° 28'	71° 39'	47° 38' 32"	
April 30.	Antigua	17° 3'	61° 50'	48° 46' 15"	At the Fort in English Harbour.
May 11.	Barbadoes	13° 5'	59° 37'	43° 45' 56"	Engineers' Wharf, Shot-hall, Carlisle Bay.
June 5.	Parà	1° 26' S.	48° 30'	23° 59' 35"	At the Consul's house (in the garden).
July 14.	"	"	"	24° 20' 50"	
26.	"	"	"	23° 56' 52"	
27.	"	"	"	23° 56' 8"	
Oct. 1.	Maranham	2° 30'	44° 18'	23° 23' 3"	On Point Francisco.
5.	"	"	"	23° 30' 37"	"
16.	"	"	"	23° 29' 54"	"
16.	"	"	"	23° 39' 41"	"
1836. Jan. 5.	Barbadoes	13° 5'	59° 37'	43° 28' 45"	The same place as before.
Feb. 6.	Bermuda	32° 18'	64° 50'	67° 17' 42"	"
April 11.	City of Caraccas	"	"	37° 16' 25"	
May 30.	Demerara	"	"	33° 56' 27"	In the Governor's garden.
July 26.	Parà	1° 26'	48° 30'	23° 31' 40"	
26.	"	"	"	23° 19' 0"	
1837. June 7.	Halifax	44° 39'	63° 37'	74° 57' 52"	In the Dockyard (at the observatory).
29.	Plymouth	50° 20'	4° 7'	69° 38' 32"	Breakwater (in the centre).
Oct. 6.	Near London ..	51° 26'	0° 18'	69° 25' 12"	At Ham, near London.

Note.—The dips and vibrations were for the greater part repeated by Mr. BYRON DRURY, Midshipman of the Racehorse, at the same times that the above observations were made.

TABLE II.
Experiments with Needle No. I.

Places.	Dates.	Time of Day.	Therm. FAHR.	Observed Times of 300 horizontal vibrations.	Concluded Times of 300 vibrations at the places between the horizontal lines, when reduced to the same epoch.	Comparative horizontal in- tensities at the places between the lines.	Comparative horizontal in- tensities. The force at Ply- mouth being unity.
Plymouth	1834. Mar. 17.	h m 2 0 p.m.	60°2	s 1284.76	s 1284.76	1.000	1.000
Bermuda..	June 17.	2 30	88.0	1113.70	1108.50	1.343	1.343
Jamaica ..	July 19.	Noon	90.0	917.50	911.84	1.985	1.985
Jamaica ..	July 19.	Noon	90.0	917.50			
Chagres ..	Sept. 19.	1 46 p.m.	87.5	891.45	891.45	1.064	2.113
Jamaica ..	Oct. 3.	2 0	89.5	920.17	919.67	1.000	
Parà	1835. July 20.	2 0 p.m.	88.6	1009.81	1010.89	1.409	1.892
Maranham	Oct. 3.	3 0	91.5	1017.70	1017.10	1.391	1.869
Maranham	Nov. 9.	2 10	89.0	1015.83			
Bermuda..	1836. Feb. 7.	1 6	75.0	1199.83	1199.83	1.000	
Demerara	May 31.	1 49	85.0	997.75	997.40	1.447	1.943
Parà	Oct. 6.	4 8	94.0	1011.98			
Maranham	Nov. 18.	11 30 a.m.	92.0	1017.77			
Bermuda..	1834. June 17.	2 30 p.m.	88.0	1113.70			
Antigua ..	1835. April 30.	3 34	88.5	968.81	968.81	1.433	1.925
Bermuda..	1836. Feb. 7.	1 6	75.0	1199.83	1159.40	1.000	

TABLE III.
Experiments with Needle No. II.

Places.	Dates.	Time of Day.	Therm. FAHR.	Observed Times of 300 horizontal vibrations.	Concluded Times of 300 vibrations at the places between the horizontal lines, when reduced to the same epoch.	Comparative horizontal in- tensities at the places between the lines.	Comparative horizontal in- tensities. The force at Ply- mouth being unity.
Plymouth	1834. Mar. 26.	h m 2 30 p.m.	59.4	s 1190.06	s 1190.06	1.000	1.000
Bermuda..	June 17.	3 6	88.0	1033.60	1032.45	1.329	1.329
Jamaica ..	July 19.	1 0	90.5	853.43	852.12	1.950	1.950
Jamaica ..	July 19.	1 0	90.5	853.43			
Chagres ..	Sept. 19.	2 10	100.0	834.66	834.66	1.056	2.059
Jamaica ..	Oct. 3.	2 45	87.5	858.71	857.70	1.000	
Parà	1835. July 20.	3 0	90.8	881.93	884.16	1.405	1.866
Maranham	Oct. 3.	4 5	88.0	888.06	889.65	1.387	1.843
Maranham	Nov. 9.	3 25	88.0	887.85			
Bermuda..	1836. Feb. 7.	2 5	76.5	1047.53	1047.91	1.000	
Demerara	May 31.	2 22	83.0	872.50	871.38	1.446	1.922
Parà	Oct. 6.	5 0	86.5	886.40			
Maranham	Nov. 18.	1 0	95.0	893.04			
Bermuda..	1834. June 17.	3 6	88.0	1033.60	1040.98	1.000	
Antigua ..	1835. April 30.	4 14	84.0	893.47	893.47	1.357	1.804
Bermuda..	1836. Feb. 7.	2 5	76.5	1047.53			

TABLE IV.
Experiments with Needle No. III.

Places.	Dates.	Time of Day.	Therm. FAHR.	Observed Times of 300 horizontal vibrations.	Concluded Times of 300 vibrations at the places between the horizontal lines when reduced to the same epoch.	Comparative horizontal in- tensities at the places between the lines.	Comparative horizontal in- tensities. The force at Ply- mouth being unity.
Plymouth	1834. Mar. 24.	h m 3 0 P.M.	58.0	s 953.40	s 953.40	1.000	1.000
Bermuda ..	June 17.	3 40	88.0	832.80	832.07	1.313	1.313
Jamaica ..	July 19.	0 43	91.0	691.30	690.49	1.907	1.907
Jamaica ..	July 19.	0 43	91.0	691.30			
Chagres ..	Sept. 19.	2 38	99.0	670.58	670.58	1.067	2.035
Jamaica ..	Oct. 3.	4 0	93.0	693.20	692.84	1.000	
Parà	1835. July 23.	4 0	88.5	707.89	710.30	1.408	1.849
Maranham	Oct. 3.	4 38	86.5	712.25	711.92	1.402	1.840
Maranham	Nov. 9.	4 34	85.0	711.98			
Bermuda ..	1836. Feb. 7.	2 47	72.5	842.73	842.91		
Demerara	May 31.	3 0	83.0	701.22	700.57	1.447	1.901
Parà	Oct. 6.	5 34	84.0	712.71			
Maranham	Nov. 19.	1 34	94.5	711.53			
Bermuda ..	1834. July 17.	3 40	88.0	832.80	838.07	1.000	
Antigua ..	1835. Apr. 30.	5 32	79.5	665.60	665.60	1.585	2.081
Bermuda ..	1836. Feb. 7.	2 47	72.5	842.73			

TABLE V.
Experiments with Needle No. IV.

Places.	Dates.	Time of Day.	Therm. FAHR.	Observed Times of 300 horizontal vibrations.	Concluded Times of 300 vibrations at the places between the horizontal lines when reduced to the same epoch.	Comparative horizontal in- tensities at the places between the lines.	Comparative horizontal in- tensities. The force at Ply- mouth being unity.
Plymouth	1834. Mar. 24.	h m 4 50 P.M.	56.9	s 874.55	s 874.55	1.000	1.000
Bermuda ..	June 17.	4 20	89.0	759.98	757.90	1.331	1.331
Jamaica ..	July 19.	3 55	87.5	626.93	624.75	1.959	1.959
Jamaica ..	July 19.	3 55	87.5	626.93			
Chagres ..	Sept. 19.	3 36	95.0	610.08	610.08	1.075	2.107
Jamaica ..	Oct. 3.	5 15	85.7	633.92	632.59	1.000	
Parà	1835. July 23.	4 0	86.9	654.06	656.02	1.413	1.882
Maranham	Oct. 3.	5 2	83.5	659.65	660.65	1.394	1.856
,"	Nov. 9.	5 13	82.5	659.73			
Bermuda ..	1836. Feb. 7.	3 17	72.0	779.53	779.95	1.000	
Demerara	May 31.	3 45	82.5	649.08	647.33	1.452	1.933
Parà	Oct. 6.	6 4	84.0	657.98			
Maranham	Nov. 19.	2 47	90.0	661.95			

TABLE VI.
Experiments with Needle B. [Horizontal Vibrations.]

Places.	Dates.	Time of Day.	Therm. FAHR.	Observed Times of 200 horizontal vi- brations.	Concluded Times of 200 horizontal vibrations.	Comparative horizontal in- tensities.
Plymouth ..	1834. Mar. 26.	h m 3 0 P.M.	59·7	915·67	s 915·67	1·000
Halifax ..	May 27.	Noon	50·7	977·95	973·09	0·885
Halifax ..	1837. June 7.	3 42 P.M.	64·0	968·23		
Bermuda ..	1834. June 15.	2 20	88·2	794·98	801·90	1·304
Bermuda ..	1836. Feb. 7.	2 0	84·0	808·82		
Jamaica ..	1834. July 16.	3 30	87·7	656·47	659·04	1·930
Jamaica ..	Oct. 1.	1 15	90·0	661·62		
Nicaragua ..	Sept. 11.	1 39	84·0	635·43	635·43	2·076
Chagres ..	Sept. 18.	Noon	100·0	639·80	639·68	2·049
Chagres ..	Sept. 19.	11 A.M.	84·0	639·56		
Alta Vela ..	1835. Mar. 6.	0 25 P.M.	92·0	686·40	686·40	1·780
Antigua ..	April 30.	3 30	89·2	688·33	688·33	1·770
Barbadoes ..	May 11.	2 0	86·5	677·51	677·51	1·827
Pará	July 23.	1 0	87·8	677·66	676·59	1·832
Pará	1836. Oct. 6.	5 0	100·0	675·57		
Maranham ..	1835. Oct. 21.	4 0	91·5	687·18	690·76	1·757
Maranham ..	1836. Nov. 18.	10 30 A.M.	93·0	694·34		
Demerara ..	May 31.	1 10 P.M.	85·0	674·00	674·00	1·846

TABLE VII.
Experiments with Needle B. [In the direction of the Dipping Needle.]

Places.	Dates.	Time of Day.	Therm. FAHR.	Observed Times of 40 vibrations in the direction of the dipping needle.	Concluded Times of 40 vibrations as before.	Comparative in- tensities in the direction of the dipping needle.
Plymouth ..	1834. Mar. 24.	h m 3 0 P.M.	56·0	s 112·52	s 111·49	1·000
Plymouth ..	1837. June 29.	3 0	84·0	110·45		
Halifax ..	1834. May 27.	3 0	52·0	98·05	97·60	1·306
Halifax ..	1837. June 7.	Noon	64·0	97·15		
Bermuda ..	1834. June 13.	3 30 P.M.	93·5	100·49	102·34	1·187
Bermuda ..	1836. Feb. 6.	3 30	72·0	104·20		
Jamaica ..	1834. July 11.	4 30	99·0	108·50	108·72	1·052
Jamaica ..	Oct. 6.	11 0 A.M.	86·0	108·95		
Nicaragua ..	Sept. 11.	2 0 P.M.	78·0	114·75	114·75	0·944
Chagres ..	Sept. 18.	Noon	92·0	117·57	117·57	0·899
Alta Vela ..	1835. Feb. 6.	Noon	113·0	116·80	116·80	0·911
Antigua ..	April 30.	3 0 P.M.	94·0	113·70	113·70	0·961
Barbadoes ..	May 11.	Noon	87·0	115·05	117·08	0·907
Barbadoes ..	1836. Jan. 5.	3 0 P.M.	85·0	119·10		
Demerara ..	May 30.	Noon	86·0	121·25	121·25	0·845
Pará	1835. July 9.	1 40 P.M.	95·0	126·97	126·97	0·771
Maranham ..	Oct. 7.	4 0	90·4	130·27	130·27	0·732

TABLE VIII.
Abstract of the Experiments.

Places.	Comparative horizontal intensities by each needle.						Comparative intensities in the direction of the dipping needle as deduced from		Means of the two last columns.	Mean dip at each place from Table I.
	No. 1.	No. 2.	No. 3.	No. 4.	B.	Means.	The horizontal needles.	The direct experiments with the dipping needle.		
Plymouth	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	69° 44' 19"
Halifax	...	...	...	...	0.885	0.885	1.204	1.306	1.255	75 15 26
Bermuda	1.343	1.329	1.313	1.331	1.304	1.324	1.203	1.187	1.195	67 36 5
Jamaica	1.985	1.950	1.907	1.959	1.930	1.946	0.988	1.052	1.020	47 1 15
Nicaragua	...	...	...	...	2.076	2.076	0.868	0.944	0.906	34 5 18
Chagres	2.113	2.059	2.035	2.107	2.049	2.073	0.851	0.899	0.875	32 30 10
Alta Vela	...	...	...	...	1.780	1.780	0.915	0.911	0.913	47 38 32
Antigua	1.925	1.804	2.081	...	1.770	1.895	0.996	0.961	0.978	48 46 15
Barbadoes	...	...	...	...	1.827	1.827	0.874	0.907	0.890	43 37 20
Pará	1.892	1.866	1.849	1.882	1.832	1.864	0.706	0.771	0.738	23 50 41
Maranham	1.869	1.843	1.841	1.856	1.757	1.833	0.692	0.732	0.712	23 30 49
Demerara	1.943	1.922	1.901	1.933	1.846	1.909	0.797	0.845	0.821	33 56 27