Five storms were identified as havig occurred in 1876. Tracks for these storms are presented in Fig. 6.

Storm 1, 1876 (Sept. 9-11).

This is a storm which existence was not known before and, therefore, it is not included in Neumann et al. (1993).The author of this study documented this new storm on the basis of the following information: 1) Bark "Alfred" (coming to New York from Flushing, Aug.9). Sept. 9, on the western part of the Grand Bank, had a severe gale from E. to N.W. and veering to N., barometer 28.65 inches (The New York Times, Sept. 21, 1876, p.10, col.7). 2) Bark "Astor". Sept. 9, encountered a heavy gale from (?) to S., lasting 48 hours (The New York Times, Sept. 22, 1876, p.8, col.7). Author's note: The first wind direction was illegible. 3) Brig "Annie and Lilly". Sept. 9, lat. 37 50 N., long. 57 36 W.,had a heavy gale from S.S.W. to N.W. with very high sea, lasting 48 hours (The New York Times, Sept. 22, 1876, p.8, col.7). 4) Halifax, Sept. 15. The steamer "Augustine", from Antwerp for New York, put in today having in tow the bark "Templar" which was picked up 400 miles from this port, disabled. On Saturday night (Sept. 9), the bark (from Montreal to Cork) experienced a heavy gale and was thrown on her beam ends (The New York Times, Sept. 16, 1876, p.8, col.7). Author's note: According to The New York Times, Sept. 20, 1876, p.8, col.6, the steamer encountered the bark at lat. 43 38 N., long. 56 36 W. on Sept. 13. 5) Bark "Graham Polley". Sept. 12, lat. 42 N., long. 55 W., spoke bark "Maria Rose", hence for Stetting, which reported having encountered a very heavy gale on Sept. 10 (The New York Times, Sept. 22, 1876, p.8, col.7). 6) Steamship "Cimbria", from New York, Sept. 7, arrived at Plymouth (England). On Sept. 10 encountered a severe gale in which she rolled heavily. The Danish vice-consul in Puerto Rico died in an accident aboard the "Cimbria" during the gale (The Times, London, Sept. 18, 1876, p.6, col.2) 7) Bark "Alexander" Sept. 11, lat. 44 17 N., long. 51 09 W., had a violent S.S.E. to N.W. gale, lasting 24 hours (The New York Times, Sept. 26, 1876, p.8, col.6).

Based on the information above, the author of this study has prepared a track for this storm. However, the confidence he placed in such a track is rather low because some of the ships which encountered the storm offered vague information. Nevertheless, he estimated the following 7 A.M. positions for the storm: Sept. 9, 40.0 degrees N., 60.0 degrees W.; Sept. 10, 43.0 degrees N., 56.0 degrees W.; Sept. 11, 44.5 degrees N., 50.5 degrees W. Apparently, the storm motion was much slower than usual for that latitude and time of the year. The author's track is shown in Fig. 6.

The barometer reading of 28.65 inches which was reported by the "Alfred" (item 1) strongly suggests that the storm attained hurricane intensity.

It would be a matter of speculation to link this storm with an alleged hurricane encountered by the brig "Mary M. Williams" (from New York to Bahia, Brazil) which was spoken at lat. 25 N., long. 43 W.on Sept. 12 (Monthly Weather Review, Sept. 1876). Although the

Monthly Weather Review related the storm encountered by the "Mary M. Williams" to the hurricane which was over the Leeward Islands on Sept. 12 (Fig. 6), that relationship is not supported by the position the bark was spoken and the route given by the vessel. A relationship between the bad weather encountered by the bark and this storm would make much better sense. However, even if both storms were indeed just one, it would not be possible to extend to lower latitudes the author's track shown in Fig. 6 because neither a position nor a date were given for the bark-hurricane encounter.

Storm 2, 1876 (Sept. 12-19).

This storm corresponds to Storm 1, 1876 in Neumann et al. (1993).

Abundant information was found in relation to this storm: 1) Bark "Mary M. Williams" (from New York for Bahia, Brazil) was spoken on Sept. 12 at lat. 25 N., long. 43 W. after having been damaged in a hurricane (Monthly Weather Review, Sept. 1876). Author's note: Although the Monthly Weather Review related this event to this storm, the position and route given for the bark do not support the alleged relationship. 2) The British bark "Mary M. Williams" encountered the storm before Sept. 12 (Vines, 1877). Author's note: Vines (1877) just quoted the Monthly Weather Review, Sept. 1876. 3) Hurricane at St. Kitts on Sept. 12. The storm passed to the N.W., lowest barometer: 29.35 inches (Garriott, 1900). 4) The vortex passed over St. Kitts during the night of Sept. 12, barometer: 29.22 inches (Vines, 1877). Author's note: The 29.22 in. pressure reading was apparently taken by a second observer on the island. 5) Kingston, Jamaica, Sept. 14. The hurricane passed near St. Thomas on the night of Sept. 12; barometer 29.45 inches (The New York Times, Sept. 21, 1876, p.1, col.6). 6) From The St. Thomas Times, Sept. 16. At sunset Sept. 12, the wind at St. Thomas was N.E., gradually rising in strength. At 4:30 A.M. (Sept. 13), it blew a hurricane and at 5 A.M. the cyclone was at its height. The center was between St. Thomas and St. Croix, being likely nearer to both places. The diameter was 100 miles. It was the worst hurricane at St. Croix in 50 years (The Times, London, Oct. 5, 1876, p.6, col.5). 7) According to The St. Thomas Times, the island of Vieques has been completely devastated by the hurricane (The Times, London, Oct. 17, 1876, p.4, col.6). 8) The hurricane at Puerto Rico, according to a correspondent, struck the S.E. point and then moved towards the W.N.W., diagonally through the island (The Times, London, Oct. 18, 1876, p.11, col.6). 9) The hurricane vortex moved over Puerto Rico between Humacao and Yabucoa at 7 A.M. Sept. 13 and emerged from the island near Mayaguez around 11:30 A.M. Barometer at Mayaguez (steamer "Marseille"): 29.24 inches (Vines, 1877). 10) Minimum pressure at San Juan, Puerto Rico, was 29.22 inches at 8:30 A.M.; maximum wind was 59 mph from the N.E. at 8 A.M. (Salivia, 1972). 11) The storm vortex moved over Cuba between Guantanamo and Baracoa. Guantanamo was in the southern portion of the vortex during the night of Sept. 14. Barometer at Baracoa and at Guantanamo (gunboat "Flecha"): 29.63 inches. The vortex was over Ensenada de Jucaro, on the southern Cuban coast, at midday Sept. 15 and emerged from the northern coast of Cuba near Sagua la Grande,

where there was a calm about midnight Sept. 15-16. Barometer at Sagua la Grande: 29.49 inches. Barometer at Caibarien (pilot boat "Omega"): 29.53 inches (Vines, 1877). 12) A slight hurricane was reported from Santiago de Cuba on Oct. 14 and from the Bahama Bank on Sept. 15. In both cases the wind veered from N.E. to S.E. (Monthly Weather Review, Sept. 1876). Author's note: The N.E. to S.E. wind shift at Santiago de Cuba seems doubtful. 13) The storm reached the steamer "Liberty" (from Havana to New York) in the Florida Straits. The vessel was wrecked and broke in pieces on the coast (Sarasola, 1928). Author's note: Actually, the accident is referred to by M. Gutierrez-Lanza in his catalog of Cuban hurricanes which is included in Sarasola (1928). 14) Savanaah, Sept. 18. The weather on Saturday night (Sept. 16) and Sunday (Sept. 17) was stormy (The New York Times, Sept. 19, 1876, p.1, col.6). 15) Wilmington, N.C. was the center of the storm Sunday morning (The New York Times, Sept. 18, 1876, p.8, col.3). Author's note: Sept. 17, 1876 was a Sunday; therefore, it refers to the morning of Sept. 17. 16) Wilmington, N.C., Sept. 18. The storm was at its height here at 8 A.M. (Sept. 17) when the wind was nearly 60 mph (The New York Times, Sept. 19, 1876, p.5, col. 4). 17) Barometer at Wilmington: 29.32 inches; at Cape Lookout, 29.46 inches. Anemometers at Wilmington and Cape Lookout were disabled at 60 mph and 73 mph, respectively. At Hampton, Va., lowest barometer was 29.10 inches at 1:20 P.M. Sept. 17 (Monthly Weather Review, Sept. 1876). 18) Schr. "Eddie Feller" encountered the storm towards the north of Cape Hatteras. At 2 P.M. Sept. 17, lowest barometer 29.40 inches, with a southerly gale force 8 out of 10 possible (Monthly Weather Review, Sept. 1876). 19) Schr. "Helen G. King" (coming to New York from Turks Is.). Sept. 17, during a heavy gale from S.E., broke foregaff, split foretopsail, stove cabin windows, etc. (The New York Times, Sept. 24, 1876, p.12, col.5). 20) Bark "Peruna" (coming from Singapore in 122 days). Sept. 17, lat. 35 07 N., long. 35 08 W. had a hurricane from E. to S.E., lasting 24 hours; lost and split sails (The New York Times, Sept. 21, 1876, p. 10, col.7). Author's note: Long. 35 08 W. is obviosly in error; long. 75 08 is likely to be the correct one. 21) At Washington, the lowest barometer was 29.15 inches about 4:35 P.M. (Sept. 17); the calm period lasted from 4:50 to 5:50 P.M. and the maximum wind was 36 mph from the W. (Monthly Weather Review, Sept. 1876). 22) Philadelphia, Sept. 17. A severe gale commenced at midnight Saturday (Sept. 16-17) and lasted till 9 P.M. tonight (The New York Times, Sept. 18, 1876, p.8, col.3). 23) The storm was one of the most severe ever known along the New Jersey coast (The New York Times, Sept. 19, 1876, p.5, col.4). 24) Alexandria, Sept. 18. The storm caused a rise in the Potomac River of several feet above high-water and the wharves were all submerged (The New York Times, Sept. 19, 1876, p.5, col.4). 25) The steamship "Rebecca Clyde" (from Wilmington, N.C. to Baltimore) has gone to pieces at Portsmouth, off Pamlico Sound. Eleven persons, including the captain, were lost (The New York Times, Sept. 20, 1876, p.1, col.6). 26) At midnight the Signal Service observer at New York reported that the total rainfall amounted to 2.63 inches and that the highest wind velocity was 50 mph at 7:15 P.M. Sept. 17. The barometer was rising at midnight with a southerly wind ((The New

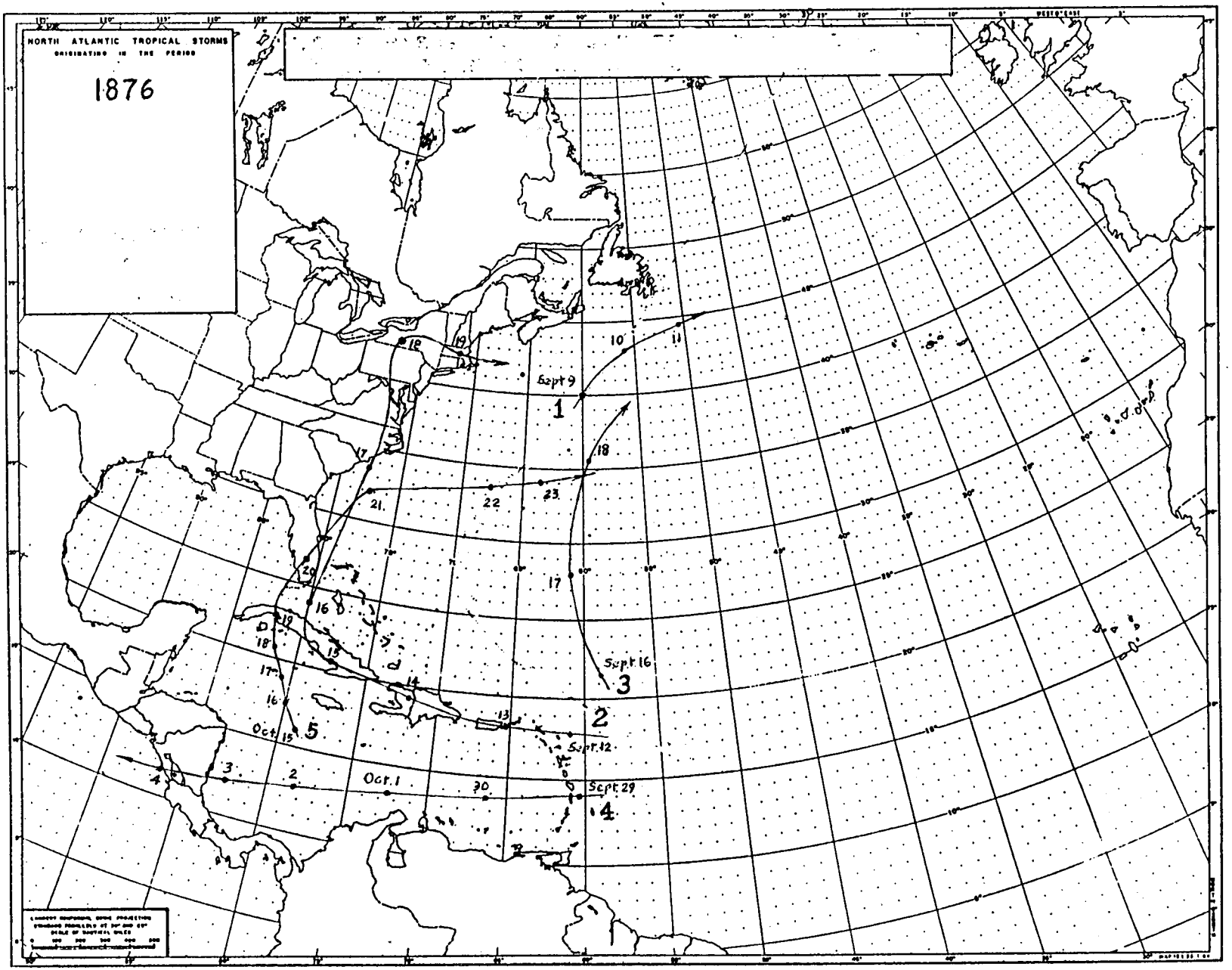
NORTH ATLANTIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
1876
Sept 9
1
Sept 16
3
Sept 12
2
Sept 29
4
Oct 15
5
Oct 1

Fig. 6

York Times, Sept. 18, 1876, p.1, col.7). 27) Boston, Sept. 18. The storm was quite severe last night (Sept. 17-18) on the bay and along the coast, and an unknown schooner went ashore in the harbor this morning (The New York Times, Sept. 19, 1876, p.5, col.4). 28) Toronto, Sept. 18. A violent rain and wind storm set in last evening and continued all night and well into this morning (The New York Times, Sept. 19, 1876, p.5, col.4). 29) Washington , Sept. 19, 1 A.M. For the lower lakes and Middle States, rising barometer, north to west winds. For New England, falling barometer, northeast winds backing to southerly with rain (The New Times, Sept. 19, 1876, p.1, col.6). 30) Washington, Sept. 20, 1 A.M. The area of low pressure has moved from New York eastward into the Atlantic and winds have backed to N.W. with clearing weather in New England (The New York Times, Sept. 20, 1876, p.5, col.5).

Based on the information above, some modifications were proposed along the track shown in Neumann et al. (1993) as for Storm 1, 1876. These modifications affected the track for Sept. 14 through Sept. 16. The author estimated the following 7 A.M. positions for these days: Sept. 14, 19.3 degrees N., 72.0 degrees W. (over eastern Haiti); Aug. 15, 20.7 degrees N., 77.7 degrees W. (on the southern coast of eastern Cuba); Sept. 16, 24.0 degrees N., 80.0 degrees W. These positions were based on information contained in item 9) and in items 11) through 13). In addition , in order to obtain a somewhat smoother and apparently a more realistic track over northeastern U.S., the 7 A.M. Sept. 18 position shown in Neumann et al. (1993) was adjusted eastward to 42.5 degrees N., 77.5 degrees W. After having introduced the above mentioned modifications, the author's track is displayed in Fig. 6.

Central pressure values indicated in several items strongly suggest that this storm only reached the status of a moderate hurricane, having been weaker over Cuba as a result of its motion over the high mountains of Hispaniola.

Storm 3, 1876 (Sept. 16-18).

This storm is the same one Neumann et al. (1993) show as Storm 2, 1876.

No information was found about this storm which apparently moved from S. to N. about longitude 60 W. from Sept. 16 to Sept. 18. Therefore, the track shown in Neumann et al. (1993) was adopted without introducing any change and reproduced in Fig. 6.

Storm 4, 1876 (Sept. 29- Oct. 4).

This is a newly documented storm by the author of this study. Documentation of this storm which, of course, is not included in Neumann et al. (1993), was based on the following information: 1) Royal Mail's "Nile" arrived at Plymouth (England) for the West Indies. Her dates were: Guadeloupe and Dominica, Sept. 28; Martinique, Sept. 30; Barbados, Oct. 1. When off Martinique, the "Nile" encountered a portion of a heavy hurricane (The Times, London, Oct. 16, p.6, col.4). Author's note: Most likely the "Nile" encountered the stormy condition on Sept. 29. 2) Panama, Oct. 19. A severe cyclone passed over the Central American States on Oct. 3

and 4. About 400 houses were blown down by the hurricane. The town of Managua (Nicaragua) was inundated on Oct. 4. The inhabitants had to climb to the top of their houses to avoid being washed away by the flood. The town of Bluefields also experienced the hurricane. Over 300 houses were blown down at that place. The same storm passed over Lake Nicaragua. The "Comodoro Adams", a lake steamer, was destroyed while lying alongside the wharf at Granada. About 20 lives were lost (The New York Times, Oct. 28, 1876, p.10, col. 4). 3) Panama, Oct. 19. On Oct. 3, at noon, the "Costa Rica" (from Panama to Acapulco, touching in Central American ports) experienced a heavy gale with a freightful sea running. On Oct. 4, the wind increased to a cyclone, shifting all around the compass. At 2:30 P.M. the hurricane-deck was blown away; the head of the main mast, maintopmast and gaff were also gone. The ship also lost one of the quarter boats and stove another (The New York Times, Oct. 28, 1876, p.10, col.3).

The author believes that, because it nicely fits a space-time continuity, the hurricane encountered by the "Nile" off Martinique and the Central American cyclone were identical. Therefore, he produced the following estimated 7 A.M. positions for the storm: Sept. 29, 14.0 degrees N., 60.5 degrees W.; Sept. 30, 13.7 degrees N., 66.3 degrees W.; Oct. 1, 13. 3 degrees N. 72.5 degrees W.; Oct. 2, 12.7 degrees N., 78.3 degrees W; Oct. 3, 12.0 degrees N., 82.5 degrees W.; Oct. 4, 11.5 degrees N., 86.5 degrees W. The author's track, which shows the storm to have moved westward with a slight southerly component, is displayed in Fig. 6. Note that, according to this track, the storm crossed Central America from east to west and then entered the Pacific, where it was encountered by the "Costa Rica" on Oct. 4 (item 3). The author believes that this is the earliest storm which is documented to have crossed Central America from the Caribbean Sea to the Pacific Ocean. The storm, which most likely attained hurricane intensity, moved over the relatively flat terrain of southern Nicaragua and over Lake Nicaragua and this is probably why it preserved much of its strength while crossing over Central America.

Storm 5, 1876 (Oct. 15-23).

This storm corresponds to Storm 3, 1876 in Neumann et al. (1993).

The following information was found in relation to this storm: 1) Starting Oct. 13, heavy swells and some rise in sea level were observed at Tunas (de Zaza) and, from Oct. 15 to Oct. 19, the sea water level rose considerably along the southern Cuban coast, flooding the Cienaga (Vines, 1877) Author's note: Tunas de Zaza is a port on the southern coast of central Cuba and the word Cienaga refers to the Cienaga de Zapata, an extensive swampy area on the southern coast. 2) Some cloud observations taken at Trinidad (central Cuba). Oct 15, nimbuses to the south. Oct. 16, nimbuses continue to the south, which is the darkest point of the horizon; at 2:30 P.M., dense stratocumulus bank to the S. and S.S.W., thickening with time. Oct. 17, 8:15 A.M., dark horizons and rain; at 2 P.M., stratocumulus banking continues to the south. Oct. 18, dark horizons, particularly to the W.S.W. and W. (Vines, 1877). 3)

Strong winds corresponding to the western side of the storm affected Grand Cayman on Oct. 17 (Vines, 1877). 4) The hurricane formed to the west of Jamaica and was strongly felt at Grand Cayman on Oct. 17, having passed N. of that island (Sarasola, 1928). Author's note: The citation was actually taken from the catalog of Cuban hurricanes by M. Gutierrez-Lanza, which is included in Sarasola (1928). 5) The severest hurricane in Grand Cayman lasted from Oct. 17 to 21. Part of the island was submerged and 170 houses were destroyed (The Times, London, Nov. 13, 1876, p.6, col.6). Author's note: The hurricane at Grand Cayman could not have possibly lasted until Oct. 21. 6) Atlas showing a storm track which was started near Cayman Islands (Instituto Cubano de Geodesia y Cartografia, 1978). 7) The hurricane can only be traced to Oct. 17 when it was encountered by vessels in the vicinity of the Cayman Islands (Monthly Weather Review, Oct. 1876). 8) Key West, Nov. 3. Brig "Mary A. Chase" was dismasted and filled during the Oct. 18 hurricane 100 miles E.S.E. of Cape San Antonio. The crew was saved and taken off by the "Race Horse" (The New York Times, Nov. 4, 1876, p.10, col.7). 9) The center of the storm made landfall on the Cienaga de Zapata (southern coast of Cuba), passed near Guines and emerged from the northern coast of Cuba to the Florida Straits just east of Havana. The barometer dropped to 28.80 inches at Batabano, to 28.32 inches at Bejucal and to 28.68 inches at Belen College Observatory, Havana (Vines, 1877). Author's note" The Bejucal reading of 28.32 inches seems to be too low. 10) At Havana, the calm corresponding to the vortex lasted for more than three hours, and the provinces of Havana and Matanzas were devastated by the hurricane (Sarasola, 1928). Author's note: Actually taken from the catalog of Cuban hurricanes by M. Gutierrez-Lanza, which is included in Sarasola (1928). 11) At 11:45 A.M. Oct. 19, the barometer read 28.7 inches at Belen College Observatory (Havana). The wind had backed from E.N.E. to N.N.E. to N. and fell to a calm (Monthly Weather Review, Oct. 1876). Author's note: 28.7 inches is an approximation of the actual value of 28.68 inches given in item 9). 12) Havana, Oct. 23. Bark "M.A. Chapman" was a total lost during the hurricane of Thursday night (Oct. 19) on Cayo Diego, near Cienfuegos. Schr. "Reeid" got very badly agrounded at Cienfuegos (The New York Times, Oct. 24, 1876, p.10, col.6). 13) Some Key West observations: 4 P.M. Oct. 19, wind N.E. 66 mph, barometer 28.92 inches; 7 P.M., wind S.W. 14 mph, barometer 28.77 inches; 8 P.M., wind S.W. 11 mph, barometer 28.73 inches; 8:45 P.M., maximum wind 88 mph; 9 P.M., wind S.W. 63 mph, barometer 28.80 inches; midnight, wind S.W. 40 mph, barometer 29.20 inches (Monthly Weather Review, Oct. 1876). 14) Brig "Nellie Ware", Oct. 19, off Jupiter, had a hurricane from E.N.E. On Oct. 20, had a gale from S.W. moderating at 4 P.M. and clearing from the W. (The New York Times, Nov. 2, 1876, p. 10, col.6). 15) Master of Schr. "Thomas N. Saveney" reported having encountered a hurricane near Great Isaac lighthouse, Bahamas. Was forced to keep vessel before the wind and run under bare poles. Struck bottom on the morning of Oct. 20 and immediately filled with water (The New York Times, Nov. 22, 1876, p.5, col.3). 16) At Cape Canaveral, barometer 28.82 inches; wind shifted from E. to N.W. (Monthly Weather Review, Oct. 1876). 17) Schr. "Annie Virdeus" is reported to have wrecked in a

hurricane near Wood Bay, Bahamas, on Oct. 21 (The New York Times, Nov. 22, 1876, p.5, col.3). 18) Bark "R.W. Griffiths" (from Cienfuegos in 28 days). Sept. 21 (it should read Oct.21), lat. 32 20 N., long. 78 30 W., had a hurricane from E. to N.N.W. , lasting 6 hours (The New York Times, Oct. 30, 1876, p.10, col.5). 19) Schr. "Julia A. Ward" reported that on Oct. 23, lat. 32 20 N., long. 76 13 W. spoke bark "Twoey" with loss of foremast, mainmast spring, and mizzen topmast gone in the hurricane of Oct. 21 (The New York Times, Nov. 1, 1876, p.8, col.6). 20) Bark "Nanny". Oct. 21, lat. 30 N., long. 70 30 W., was near the center of a hurricane for 6 hours (The New York Times, Nov. 2, 1876, p.10, col.6.). 21) American bark "Montana", from New York to Pernambuco, arrived at St. Thomas on Nov. 25, with loss of bowsprit and foremast and reported having experienced a hurricane in the vicinity of Bermuda (The Times, London, Dec. 9, 1876, p.10, col.4). Author's note: Because one entire month elapsed from the time this storm passed near Bermuda and the time the "Montana" arrived at St. Thomas, there is a possibility that the hurricane encountered by the "Montana" could have been a later storm of non-tropical characteristics. 22) At Bermuda, a S.E. gale commenced on Oct. 20 veering to S. on Oct. 21 and to S.W. by morning Oct. 22 with barometer 29.35 inches and heavy rain. Morning of Oct. 23, barometer 29.30 inches, gale began to moderate and veered to W. by noon (Monthly Weather Review, Oct. 1876).

After a careful evaluation of the information contained in the above items, the author of this study decided to propose some modifications along the track displayed in Neumann et al. (1993) as for Storm 3, 1876. Based on items 1) and 2), the track was started on Oct. 15 with an estimated 7 A.M. storm position near 16.0 degrees N., 79 degrees W.; however, the storm might have formed about two or three days earlier as heavy swells and some rise of the sea level were observed at Tunas de Zaza as early as Oct. 13 (item 1). What will be very difficult to accept is the formation of the storm in the vicinity of the Lesser Antilles on Oct. 12-13. Such an event would not have possibly caused the sea conditions mentioned as having occurred at Tunas and, in addition, any storm in the Lesser Antilles very likely would have been reported by The Times, London, and this was not the case. Author's estimated 7 A.M. positions for other days were as follows: Oct. 16, 17.5 degrees N., 80.0 degrees W.; Oct. 17, 19.0 degrees N., 80.7 degrees W.; Oct. 18, 20.7 degrees N., 81.7 degrees W.; Oct. 19, 22.7 degrees N., 82.0 degrees W.; Oct. 20, 26.7 degrees N., 81.0 degrees W.; Oct. 21, 32.0 degrees N., 77.3 degrees W.; Oct. 22, 33.5 degrees N., 67.7 degrees W.; Oct. 23, 34.0 degrees N., 63.5 degrees W. The positions were chosen after trying to satisfy the information in items 3) through 22) as much as possible. The author's track for the storm is shown in Fig. 6.

Lowest barometer readings of 28.68 inches at Havana (item 9) and 28.73 inches at Key West (item 13), which were taken at the center of the storm, suggest an intensity corresponding to a moderate hurricane.