

Darwin , Chagas' disease, and the HMS Beagle in South America

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INTRODUCTION

Darwin's adult lifetime illness has been under discussion for well over a hundred years. A proliferation of explanations have accumulated in the literature to include : brucellosis, malaria, typhoid, typhus, narcolepsy, diabetogenic hyperinsulinism, diaphragmatic hernia, Crohn's disease, hypochondria and all sorts of other psychosomatic disorders (Keith 1955; Simpson 1958; Kohn 1963; Woodruff 1965, 1968; Roberts 1966; Colp 1977, 2008; Wilson 1977, 1978). Professor S. Adler in 1959 is probably the first investigator to notice from Darwin's Voyage of the Beagle, Chapter 15, 25 March 1835, his encounter with the primary vector of Chagas' disease, *Triatoma infestans*, "...great black bug of the Pampas..." (Adler, 1959 p. 1103). In his 1959 letter to Nature, Adler, an accomplished parasitologist, points out the course of investigation which must be undertaken to examine the hypothesis of Chagas' disease: "It is obvious that all attempts to explain Darwin's symptoms must be based on a detailed analysis of the events recorded in the voyage of the H.M.S. *Beagle*, because there is nothing of any medical significance prior to the voyage which could throw light on his subsequent illness." (p.1103). This challenge has never been taken up by subsequent scholars. Scant discussion of the events of the five year voyage of the Beagle are found throughout the ensuing literature, including: Alvarez, Woodruff, Colp, *et cetera* . Two important works clearly layout the chronology of the Beagle voyage including discussions of Darwin's *T. infestans* encounters. K.G.V. Smith (1987) makes note of two encounters Darwin had with *T. i.* and he also separates out from the itinerary of the voyage the days at sea from days on land. J.J. Parodiz (1981) also mentions Darwin's encounter with *T. i.* at Luxan and working from the Diary (1934), letters, Notebooks and the Journal (1845) he lists chronologically all the arrivals and departures "... of the Beagle and Darwin's travels overland. " Unfortunately Professor Adler passed away in 1965 before he could undertake a thorough investigation himself. Dr. Michael Kelly, in a letter to the editor of the J. of Chron. Dis (1967, P.341) entitled "Darwin really was sick" quotes Adler; "Darwin's symptoms fit Chagas' disease like a glove." Adler, in his 1959 letter to Nature and his 1965 letter to the British Medical Journal, emphasizes not only the *T. infestans* blood-sucking incident in Luxan but Darwin's continual exposure to *T. infestans* during much of his time in South America.

A basic tenet of good medical practice includes taking a thorough history of the patient (Roberts 1966:723). We have commenced a thorough investigation “... of the events recorded in the voyage...” (Adler 1959) in a very close reading of Darwin’s and related correspondence before, during and shortly after the voyage of H.M.S. Beagle (Burkhardt and Smith 1985; Burkhardt 2008) and of his diary of the voyage edited from the MS by Nora Barlow (1934). This diary is a much better reference to use in exploring events of the five year voyage because it is a nearly day by day, continuous, flowing account whereas the Journal of Researches (Darwin 1839, 1845) is arranged so as to compress different visits to specific regions in the same chapter even though they did not occur in a continuous fashion. For example, a couple of separate trips to the Falklands are combined into one chapter.

Darwin’s health prior to the voyage appears to be perfectly normal. His heart palpitations are not inconsistent with what any young and healthy man or woman might experience in anticipation of two years at sea in the 19th century (Burkhardt & Smith 1985, various letters from pp.128-151; F. Darwin 1950, p. 40; de Beer 1959, p. 7). R.W. Clark (1984) in his biography on Darwin simply states, “Perhaps he was suffering from no more than a simple case of nerves.” (p.20). Moreover, his skin conditions are likewise not inconsistent with the use of arsenic as a medicine , also as a preservative and possibly other chemical exposures as a child during chemistry experiments with his older brother Erasmus (Colp 1977; Desmond and Moore 1991). Anxiety and fear over his father’s opinions of the impending excursion are perfectly normal for any young adult from a loving family who has great respect for his father, but who has been offered a lifetime opportunity rarely encountered (Burkhardt & Smith 1985, various letters from pp. 128 - 151). As for any other of the “ psychological symptoms” we feel they are so speculative as not to be worthy of further comment. In this regard we note Dr. Roberts’ comments in his editorial “Reflections on Darwin’s Illness”. “In all candor, I must side with Adler, who aptly commented that ‘... a purely psychological aetiology for Darwin’s illness cannot be accepted as conclusive until all other factors have been eliminated.’” (Roberts, 1966). Darwin was an excellent horseman, a crack shot with a the flintlock pistol and the

muzzle loaded musket, possessed of great physical strength and endurance, and highly motivated professionally. Additionally, he had been recommended as a naturalist and captain's companion for this voyage by his Cambridge professor, John S. Henslow, a senior naturalist of the day (Clark 1984; Bowlby 1990) under whom he had studied for almost three years.

It is probably fortuitous for many reasons that Darwin was perpetually seasick - at every landfall from the first to the last he was ashore traveling, collecting, observing, dissecting, writing, skinning, preserving and thinking. In this paper we will attempt to calculate the number of days Darwin was actually on land in South America in the particular areas of the continent where vectors of Chagas' disease are encountered. We will break this time of days into categories such as travel by foot, on horseback, by boat or other water craft close to shore and on inland waters, nights spent in the open , in "dirty" towns, vendas, post houses or estancias, and in clean quarters. Additionally it will be important to discuss Darwin's fearless fascination with all aspects of nature. In this regard it is important to examine his encounters with insects specifically; aside from his intrepid encounters with jungles, pampas, salt flats, deserts, ocean travails , virtual arctic conditions in Tierra del Fuego and the Cordillera, volcanoes and earthquakes. Finally, every single incidence of illness on the voyage will be discussed, excepting seasickness and some of the times he complained of suffering from extreme cold or heat. The aim of our study is to demonstrate that there was a very substantial likelihood Darwin was exposed to a Hemiptera vector for Chagas' disease, that he did contract this disease caused by *Trypanosoma cruzi*, and this was the underlying cause for his nearly lifelong adult illness.

Between 28 February 1832 and 7 September 1835 Darwin spent 1264 days in South America including time in the surrounding waters along the coast, near islands and on inland waters such as large rivers. 581 days were actually spent on land and 205 days were spent on inland waters ; all in areas endemic for Chagas' disease and the presence of the *T. infestans* insect vector which transmits the *Trypanosoma cruzi* parasite between primarily humans, smaller mammals and birds. This zone stretches from about 46 degrees south latitude and about 10 degrees south latitude. *T. i.* is the primary insect vector for Chagas' disease because it favors

ecological conditions created by humans their pets and smaller farm animals and birds. However, there are a half dozen or so other species in the *Triatoma* genus and the species of *Rhodnius prolixus* which are also possible vectors overlapping the *T. i.* range to include virtually all of South America excluding the tropical jungles of the Amazon and Orinoco and most elevations above 9000 feet. The number of days given above (581 and 205) are taken only from those 1264 days during which Darwin was in areas known today to be infested with the *Triatoma* vectors. K.G.V. Smith edited Darwin's Insects: Charles Darwin's Entomological Notes (1987). In this monograph Smith goes through the entire voyage itinerary enumerating days at sea and days on land (pp. 18-19). The days on land amount to 1017. This lesser amount from our 1264 is probably accounted for by the inclusion in our count of inland water travel during much of which Darwin was off on land in the day light hours but traveling at night on a small vessel. Parodiz monograph (1981) also includes a chronology (pp. 25-40) without a count of days on land. However, the historical background and subsequent 19th century place name changes are invaluable.

Further breakdown of Darwin's daily activities is necessary and possible because follow up on Prof. Adler's suggestion in his 1959 letter to Nature seems never to have been taken seriously by subsequent scholars (see quote above, p.1103). We have collected the data to be presented in this study from Darwin's diary of the voyage (1934), readings of several hundred letters covering the entire period just prior to the voyage to through the end of 1837 (Burkhardt and Smith 1985; Burkhardt, 2008; Litchfield 1915), Darwin's Zoology Notes (Keynes 2000), Insect Notes (Smith 1987), Journal of Researches (Darwin 1839) and several important biographies of Darwin (Bowlby 1990; Brent 1981; Browne 1995; Clark 1984; Desmond and Moore 1991). The diary however is the principle source of information because it is a nearly daily accounting of his travels, residences, encounters with insects, and many illnesses suffered throughout his South American sojourn.

Of the 581 days on land and 205 days on inland waters we have further broken down Darwin's activities into four categories. Under travel conditions we have separated out and

counted days he was traveling by walking from days he was on horseback. Occasionally throughout the diary it is difficult to establish his travel patterns so those days are not counted or guessed. Also a count was taken of days / nights he stayed in a “clean” house or home usually in a town which may or may not have been free of domestic pets, other small animals, and *T. infestans*; and days / nights when he slept outside or in an estancia, post house, venda or other temporary, poorly constructed, unclean, and unkempt dwelling. This latter category of overnight stays would include conditions with a high probability for the presence of *T. i.* Throughout the diary Darwin often was explicit about the cleanliness or lack thereof for the places he stayed. Darwin of course since childhood was an active outdoors person traveling and camping in the open. In fact he often preferred in South America to sleep out under the sky and stars. We do not take his comments and complaints of “dirty, filthy towns” to mean he was afraid of them for health reasons, merely that growing up in an English landed gentry family he did appreciate a well constructed, clean and furnished dwelling. It did not have to be Shrewsbury, Maer Hall or Buckingham Palace.

The 205 days of travel on inland waters included : days / nights on the Beagle within easy distance to the shore by a small boat, time traveling on rivers or along the seashore in much smaller vessels many of which were crowded, cramped and unclean, From all of these vessels Darwin frequently would be off into the forest, cliffs, rock formations, surrounding plains or up a creek on foot or the seashore. Although much of these 205 days undoubtedly included the possibility of exposure to *T. i.*, it probably was less likely than when he was well placed on land. Nevertheless, it is important to point out that he was constantly collecting animals, birds, plants, aquatic organisms and insects; thereby increasing his chances of an exposure beyond anyone else with him ashore or on the Beagle.

Darwin travelled 228 days by foot. These would probably be days during which maximum exposure to *T. i.* would occur because of his collecting and carrying specimens. He traveled 306 days by horseback. Horses and cattle are not affected by *T. i.*, probably because of their thicker skin; but again Darwin was always ready to dismount for collecting, shooting game

or specimens, *et cetera*. Included in these 306 days on horseback are a few days by coach, e. g. when he was sick and traveling back to Valparaiso (p. 249, Diary). In his overland travels Darwin virtually never went alone. Almost always accompanied by his servant and professional assistant, Syms Covington, his party very frequently included acquaintances, shipmates, hired companions, guides, guards, other travelers, soldiers, cowboys and ranchers (Browne 1995, pp. 228-230). Almost certainly dogs were present as part of the party on many occasions as being useful for companionship, guards and protection. Domestic pets are definitely vectors for the transmission of Chagas' disease via the various Hemiptera species. Overnight stays include 270 in a town or relatively clean home or estate. These overnight stays probably lessened Darwin's chances for exposure to *T. i.* 284 overnight stays were outside or in a venda, estancia, post house or similar poorly constructed and/or unclean dwelling. Occasionally Darwin actually chose to sleep outdoors rather than in an unclean dwelling, e.g. on 11 February 1835 after traveling on horseback for several days he slept outside at least one night rather than being inside a "... so dirty..." house infested with fleas (p. 273, Diary). Of course these 284 nights probably constitute the times of maximum exposure to *T. infestans* and other Hemiptera vectors for Chagas' disease.

We have identified 14 illnesses during Darwin's time on land in South America. In this count we do not include most of the cases where he has clearly suffering from over exposure to intense cold or heat. Additionally, none of the specific seasickness bouts are included. All of these 14 illnesses were preceded by travels on horseback, foot and sleeping outside or in what we have identified as unclean dwellings. We are not however, intending to make the case for most of these 14 illnesses being Chagas' disease symptoms or outbreaks, merely that heightened exposure to *T. i.* may have occurred during these times. Clearly most all of these illnesses probably had nothing to do with Chagas' disease symptoms.

INSECT ENCOUNTERS

Since a young man Darwin had been an enthusiastic insect collector. The well known incident when he popped a beetle into his mouth to free up a hand for a third beetle clearly establishes a pattern of behaviour from which an insect bourn disease could be contracted (Brown, 1995, p.101). In the Diary (1934) of the voyage there are descriptions of six specific incidents involving insects. The first occurs in the evening of 15 October 1833 when Darwin describes a warm, tropical evening. He had been traveling down the Parana by boat from Santa Fe, frequently disembarking to collect , *et cetera*. At one point there was an “... abundance of fire flies, & the mosquitos very troublesome. I exposed my hand for five minutes, it was black with them: I do not think there could have been less than 50, all busy with sucking.” (Diary pp. 188-189). The second occurs on 11 February 1835 in Chili on the island Chiloe. Darwin slept outside because of the “... so dirty ...” house. Nevertheless, “... in the morning, there was not the space of a shilling on my legs which had not its little red mark where the flea had feasted.” (Diary p. 273). Then, on the 26th of March 1835 the now famous encounter with the *Triatoma infestans* took place in Luxan, just a few leagues south of Mendoza. “It is most disgusting to feel soft wingless insects, about an inch long, crawling over ones body; before sucking they are quite thin, but afterwards round & bloated with blood, & in this state they are easily squashed.” (Diary p. 298). The fourth insect encounter mentioned in the Diary (p. 313) on 21 May 1835 took place several days earlier when Darwin and Captain Fitzroy took up rooms in Coquimbo for several days (p. 312). In the 21 May entry: “I enjoyed my night’s rest here from a cause the force of which will not be understood in England - there were no fleas! The rooms in Ciquimbo swarm with them; ...” . Darwin’s second documented *T. i.* encounter probably occurred about the 12th of June 1835 when he was traveling via horseback and afoot up the Copiapo Valley in Chili. “... sucks very much blood, frequents houses; but this was caught in sandy ravine of cordilleras of Copiapo; called Benchuca, caught in my bed.” (K.G.V. Smith 1987 pp. 89, 96-97; Keynes, 2000 p.411). The sixth insect encounter is also the third Darwin records with *Triatoma infestans*. Having just arrived aboard the Beagle in Iquique, Darwin describes in the Insect Notes (K.G.V. Smith, 1987; and the Diary, 1934) a benchuca sucking blood apparently from a Beagle officers’ presented finger. I believe this occurred aboard ship because the bug was kept alive for four months when “... it was ready, if allowed, to suck more

blood.” Of course Darwin mentions insects many times throughout the Dairy; the six encounters briefly discussed above merely document how intimate his relationship with insects could be. Undoubtedly there were other similar encounters which he did not record in the Dairy, Insect Notes, Zoology Notes or letters home. Smith (1987) concludes in his comments in Insect Notes: “The chances of his contracting Chagas’ disease do therefore seem rather high.” (p. 97).

BEAGLE ILLNESSES

We have identified fourteen episodes of illness while Darwin was in South America occurring during the 1264 days. As noted above these do not include any of the bouts of seasickness from which he regularly suffered although by all accounts continued to work during sporadic short periods throughout those days; nor do we include most of the sufferings from overexposure to cold or heat. Illnesses follow in chronological order:

1) The first illness occurred in Bahia shortly after their initial South American landfall on 28 February 1832. From 6 to 12 March 1832 because of a “...pricked ...” “...knee some days since, & it is now so much swollen that I am unable to walk...” (Diary, p. 42). He was in great pain and was evidently unable to sit up for very long periods. On 13 March he still was “Unable as yet to leave the ship.” (p. 43) . However, the next day he was up and out in a small boat exploring the beaches followed by long walks in the heat collecting “... a great number of plants & insects;...” (p.44).

2) On 11 April 1832 while traveling by horse outside of Botofugo he was “...unwell, with a little shivering & sickness;...” “...miserably faint & exhausted; often thought I should have fallen off my horse.”, “ All night felt very unwell: ...” (p.52). He cured himself with cinnamon and port. By 13 April he was much better and was traveling on by 14 April. (pp. 53-54).

3) After several days walking, collecting, *et cetera* near Rio de Janeiro about 10 May 1832 was for four days “... almost laid up by an inflammation in my arm. Any small prick is very apt to become in this country a painful boil.” (p. 61). On the 14th of May Darwin reports his arm is nearly well and he is off visiting, walking, collecting, *et cetera*.

4) On 5 August 1832 Darwin was included as part of a heavily armed party of sailors and marines, 52 in number, who nearly became involved in action ashore related to local political and military issues in Rio de Janeiro. He returned to the Beagle that evening, “As I had a bad headache,...” (p. 87). Of course this short episode may well have been caused by normal anxiety and tension prior to possible impending military action. That evening the Beagle was “...cleared for action.” which is undoubtedly a noisy and fast operation. It seems likely that Darwin’s space on board was not involved with this action because his cabinets, shelves, library and the work table in his approximately 10 by 10 foot space were located in the poop cabin just aft of port and starboard brass six pounders. (Brent 1981, illus. on p.131; Desmond and Moore 1991, illus. 21; Burkhardt 2008, illus. 3). In any event, apparently not a shot was fired.

5) After traveling several days on horseback (and afoot when the horses were too weak) over swamps, marshland and often miles of dry, hot, salt encrusted terrain in Patagonia outside of Bahia Blanca Darwin reports (20 August 1833) suffering much from thirst, poor food supply and the heat. (pp. 166-167).

6) On 9 September 1833 he mentions severe leg cramps from hiking the peaks around Bahia Blanca, Argentina. Although this doesn’t sound like an illness, Darwin is quite descriptive of the cramps, pain, resting, *et cetera*. He attributed it to “... the great change in kind of muscle action from that of hard riding to still harder climbing.” (p. 176).

7) After leaving for Santa Fe several days before by horse and sleeping out Darwin arrived just short of Santa Fe on 7 October 1833 “...unwell & feverish,...”. “And unwell in bed.” in Santa Fe (3-4 October, p. 186) .

- 8) Back on the horses again he reports “Not being quite well...” on 5 October (pp. 186-187). Subsequently he spent several days walking and doing geology.
- 9) On 16 November 1833 after riding three days or more and “Not being quite well, stayed the whole day at this house.” (p. 192). On the 17th he is off on horseback again and crossing the Rozario.
- 10) Darwin “...was very feverish in bed.” the 12th and 13th of January 1834. He was aboard the Beagle but had been spending many days ashore mostly afoot as the ship was working the coastal areas around St. Julian and Santa Cruz. He was apparently exhausted again from overexposure to heat and the lack of adequate, clean drinking water. There was apparently also some tension created from the presence of a French whaler in the area because “The French Government(s) gives a great bounty to all whalers.” (p.205, Diary). This particular illness incident actually occurs outside the range of *Triatoma infestans* so could be disregarded. Darwin had been out of the *T.i.* range for about forty days.
- 11) During approximately 14-15 September 1834 after having traveled with the Beagle through Tierra del Fuego and starting up the western coast of South America in Chili, Darwin spent two of these days (or to the 17th) “...unwell...” (p. 246) near the Yaquil gold mines in the town of Rancagua. “I staid in this place four days, during two of which I was unwell.” This incident of being unwell may be connected to the next two incidents (12 and 13) as they all occur very close in time.
- 12) Continuing to travel by horse and nearly always sleeping out or in unclean quarters, Darwin reports “I felt during the day very unwell, & from this time to the end of October did not recover.”(19th or 20th September 1834, pp. 248-249).

13) He stayed in a "...house close to the sea." at Navedad south of the Rapel River. On 23 September "I staid here the whole ensuing day, & although very unwell managed to collect many marine remains from bed of the tertiary formation,..." (p. 249). He continued to travel towards Valparaiso. "At night I was exceedingly exhausted;..." (p. 249). The September 25th entry reads: "Necessity made me push on & I contrived to reach Casa Blanca. It was wretched work; to be ill in a bed, is almost a pleasure compared to it." He took a carriage to Valparaiso and "... remained in bed till the end of October."

14) On 9 April 1835, following 14 days after his famous encounter with the benchuca at Luxan and still traveling on horseback from the cordillera, he records in the Diary: "From this day till I reached Valparaiso, I was not very well & saw nothing & admired nothing." (p. 306). For the 15th still traveling to Valparaiso "... was two days & a half on the road endeavoring to geologize." Finally arriving at Valparaiso on the 17th Darwin had been "...not very well..." for about nine days. Although he still subsequently was to experience his second flea encounter and two more incidents with *T.i.* no more illnesses are recorded for the entire remainder of the voyage. They sailed from South America on 7 September 1835 and arrived back in England on 2 October 1836.

All these episodes which we have identified as being illnesses occurred following a few days to weeks or more travel by horse or afoot. During the periods of illness Darwin often continued to travel as well as stays in houses, "... an unfurnished room." (p. 186), and a gold mine. Many of the illnesses include a significant element of exhaustion. According to Professor Adler "... exhaustion after physical effort..." is a symptom of Chagas' disease (Adler 1959, 1965). Moreover, Adler says "Infection with *T. cruzi* are protean in their manifestations." (1965). This statement is supported by the recent Nature outlook supplement on Chagas' disease (2010, 24 June; J.Clayton; J.R. Coura and P.A. Vinas). In his second book on Darwin's illness Colp (2008) comments on the episode which we have designated as illness 14 above: "These eight days of unwellness may have been an acute episode of subclinical Chagas' disease."

BIBLIOGRAPHY

Adler, S. 1959 Darwin's Illness. *Nature* 184: 1102-1103.

_____ 1965 Darwin's Illness. *British Medical Journal* 1: 1249-1250.

Alvarez, W.C. 1959 The nature of Charles Darwin's lifelong ill-health. *New Engl. J. of Med.* 261: 1110-1112.

Barlow, Nora 1934 Charles Darwin's diary of the voyage of H.M.S. "Beagle". Cambridge Uni. Press, London.

deBeer, Sir Gavin, ed. 1959 Darwin's Journal. *Bull. British Museum (Natural History)* Historical Series 2: 1-21.

Bowlby, John 1990 Charles Darwin: a new life. W.W. Norton & Company, New York.

Brent, Peter 1981 Charles Darwin: "A man of enlarged curiosity". Harper & Row, New York.

Browne, Janet 1995 Charles Darwin: voyaging, Volume I of a biography. Knopf, New York.

Burkhardt, Frederick, ed. 2008 Charles Darwin: the Beagle letters. Cambridge Uni. Press, Cambridge.

Burkhardt, F. and S. Smith, eds. 1985 The correspondence of Charles Darwin, Vol. I 1821- 1836. Cambridge Uni. Press, Cambridge.

_____ 1986 The correspondence of Charles Darwin, Vol. 2 1837-1843. Cambridge Uni. Press, Cambridge.

Clark, Ronald W. 1984 The Survival of Charles Darwin. Random House, New York.

Colp, Ralph, Jr 1977 To be an invalid. Uni Chicago Press, Chicago.

_____ 2008 Darwin's illness. Uni. Press Florida, Gainesville, Florida.

Darwin, Charles 1839 Journal of researches into the geology and natural history of the various countries visited by H.M.S. Beagle , under the command of Captain Fitzroy, R.N. from 1832 to 1836. London: Henry Colburn.

_____ 1845 Journal of researches into the natural history and geology of the countries visited during the voyage of the H.M.S. Beagle round the world, 2nd edition. London: John Murray

Darwin, Sir Francis, ed. 1950 Charles Darwin's Autobiography. Henry Schuman, New York.

Desmond, A. and J. Moore 1991 Darwin Warner Books, New York.

Keith, Sir Arthur 1955 Darwin revealed. Watts & Co., London.

Kelly, M. 1967 Darwin really was sick. J. chron. Dis. 20:341.

Keynes, Richard, ed. 2000 Charles Darwin's zoology notes & specimen lists from H.M.S. Beagle. Cambridge Uni. Press, Cambridge.

Kohn, L.A. 1963 Charles Darwin's chronic ill health. Bull. of the Hist. of Med. 37:251.

Litchfield, Henrietta, ed. 1915 Emma Darwin: a century of family letters 1792-1896. Vol. I.
D. Appleton and Comp., New York.

Parodiz, J.J. 1981 Darwin in the New World. E.J. Brill, Leiden.

Roberts, H. J. 1966 Reflections on Darwin's illness. J. chron. Dis. 19: 723-725.

Simpson, G.G. 1958 Sci. Amer. 199 (2): 117.

Smith, K.G.V., ed. 1987 Darwin's insect: Charles Darwin's entomological notes. Bull. Brit.
Mus., (Nat. Hist.) 14 (1): 1- .

Wilson, L.G. 1977 The puzzling illness of Charles Darwin. J. of the Hist. of Med. and Allied
Sciences. 32.

_____ 1978 Fevers and science in early nineteenth-century medicine. J. of the Hist. of
Med. and Allied Sciences. 33: 286-407.

Woodruff, A.W. 1965 Darwin's health in relation to his voyage to South America. Brit. Med. J.
1: 745-750.

_____ 1968 The impact of Darwin's voyage to South America on his work and health. Bull.
N.Y. Acad. Med. 44: 661-672.

