‡4 On the Navigation of Polar Explorer Robert Peary

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A Peary's Curious Memo

A1 Considering the still-simmering discussion of how close Robert E. Peary came to the North Pole in 1909, and the scant[2] evidence of his navigational methods, a revealing note (found among his papers) seems to have hitherto received too little attention. [Though, Peary-defender Wm. Molett 1989 p.142 calls this "probably the most important document in all the Peary archives as pertains to his navigation". Compare to fn 2.] It is a memo, in Peary's distinctive hand (Peary 1909 records, official US National Archives microfilm, frame #0267), which reads:

> The sun setting[3] due E. & W. Mar. 21 & 22 gave accurate checks on compasses, also just touching northern horizon Mar. 26 & 27.

A2 Molett 1989 pp.142-143 argues that this note explains Peary's steering. However, as stated, the note is unrealistic for two reasons — so unrealistic that, had Peary even tried either method he would never have written the note in that form. These reasons are: [1] the rapid change of solar declination around equinox and [2] the slow passage of the sun through the horizon so close to the Pole. Below, it is shown (§E5) how a much surer orientation can be obtained by using transverse (E-W) sextant observations.

B Orientation

B1 It is hard to determine direction to the Pole when travelling over shifting ice in a world without landmarks, comparable to the difficulty of locating a tiny underwater reef in the Pacific from a canoe. Celestial navigation is in some respects hampered (in others, aided: Rawlins 1973 p.154) by the almost horizontal daily rotation of the skies. (For discussions of navigational methods proper to the problem, see, e.g., Mohn 1915, Rawlins 1973 & 1992, and the Navigation Foundation Report 1989.) A magnetic compass can be useful; but, along Peary's intended 1909 route [1] the terrestrial magnetic field is much weaker than in most regions of the Earth (Rawlins 1973 p.139), [2] compass-north is somewhat south of due west, and [3] the compass needle's north end pointed (Rawlins 1992 fn 94) about 30° to the right of the distant North Magnetic Pole [the south pole of the terrestrial magnet].

[1] [All footnotes by DR.] Thoroughly brought up in the mathematical sciences, Hanne Christiansen is one of the most technically competent of scientific historians. (She was first introduced to the field by a stimulating series of discussions with the late highly respected University of Copenhagen mathematician & historian, Olaf Schmidt, a retiring but unusually able and principled scholar.) Though she is now research associate professor in the History and Prehistory of Astronomy, we are grateful that she occasionally delights us with excursions of the present type, which point up her exceptional ability to discern what everyone else has overlooked. (Mailing address: Sauntesjev 28 A, DK-2820 Gentofte, DENMARK. Telephone: +45-3965-2524.) [Typically scrupulous note by HDC: It has pleased the publisher occasionally to couch my rather straightforward paper in *DIO* style, and to add a few details — including footnotes which provide a wealth of information, besides stressing some extra mathematical niceties.] (See *DIO 6* ‡3 fn 11.)

[2] See Rawlins 1991 §§C6&D1 (or Rawlins 1992 §K4) for the only statement Peary made in his diary attempting to explain his 1909 steering: "setting course by moon, our shadows, etc." (This is a rough method which would have been replaced by sextant observations when Peary began closing in on the Pole — a process which was aborted at birth on 1909/4/6-7 when he confirmed how impossibly far he was from his goal: fn 20.) Note the striking coincidence that this is the ***sole*** nontrivial deletion he made when reading his diary extensively to Congress in 1911. See Rawlins 1991 §C6. Note also the point (*ibid* §C4) emphasized by Oliver M. Miller of the American Geographical Society.

[3] Rawlins 1992 fn 44 cocks a playful eyebrow at the Peary memo's report that his party observed sunset in the east . . . .

B2 Here we concentrate on the memo above (§A1, also cited in the Navigation Foundation Report 1989[4] and Rawlins 1992 fn 44). It is on a loose, undated slip of paper. Rawlins *loc cit* comments on "the excruciatingly gradual effects" of sunrise & sunset, which make it hard to judge the moment when they occur. But, while the *hourly* changes of solar altitude are surprisingly slow in the polar regions, the effects of *daily* changes are surprisingly high there (mornings & afternoons) near an equinox. (E.g., at 86°N latitude, it will take about 0.4 hours, i.e., 6° of azimuthal variation, for the rising or setting sun to move as many vertical arcminutes as the sun moves northward in declination in a day at Vernal Equinox.)

B3 To evaluate the horizon position (azimuth) of the sun for the dates mentioned, we must know the geographical latitude. A figure of 85°.6 N[5] is about right for the sunrise of March 21. (Vernal Equinox was at 1:26 local apparent time [LAT] on 70°W.) The Peary party intended to approach the Pole along the meridian of longitude 70°W (where local time is 4^h40^m less than Greenwich time). No sextant observations were taken for longitude.[6]

B4 The age-old methods of observing have focussed on azimuths of either first/last gleam or of disk touching horizon. Now, when the equinoctial sun (declination $\delta = 0$) sets at 85°.6 N, its disk (of width exceeding a half degree) takes so long to cross the horizon (moving along a path tilted only about 4°.4 with respect to horizontal, after all) that it slides a huge angular distance in azimuth between the time its lower limb touches the horizon and the time its upper limb finally disappears below the horizon. If we (fictionally) hold solar declination[7] latitude, & atmospheric refraction[8] constant, then it is easy to see that, at latitude 85°.6 N, the 32′-wide solar disk will require about

$$(1^m/15') \cdot 32' \sec 85°.6 = 28^m \tag{1}$$

to completely cross the horizon — which corresponds to 7° of azimuthal motion. Such slackness suggests that observing sunset is a less than ideal method for precision-checking of compasses' orientation.

C Solar Shifting

C1 But that is not the only difficulty with the Peary memo (§A1), for the sun's declination does not stay constant (as we assumed[9] for convenience at §B4) — instead, it increased

[4] The Nav Fnd Rpt (pp.49 & 55) treats the §A1 memo as navigationally sound; p.55: "The sun's setting and rising on March 21st and 22nd gave an east and a west that was easily converted to a useable compass heading to the Pole from his locations at the time." However, the §A1 memo *neglects to impart this heading*. (See below: fn 20.) And in 1911 Peary contradicted the memo by telling Congress that in 1909 he did *not* determine the direction of the compass: Rawlins 1991 §C2.

[5] The estimate is 85°33′N at Peary 1910 p.338.

[6] Peary's 1911 statement before Congress. (See Rawlins 1991 §C3 and Rawlins 1992.) Acknowledged by the Navigation Foundation (e.g., *Washington Post* 1993/6/1).

[7] Near the Vernal Equinox, variation of declination during the setting process will lengthen that process; the same effect will shorten the rising process. Vice-versa for Autumn Equinox.

[8] See the 1990 descriptions, by B.Schaefer & W.Liller (*PASP 102*:796), of the large fluctuations in atmospheric refraction very near the horizon even in temperate climes, variations which it is well known will only be more exaggerated & unpredictable in the polar regions.

[9] At this latitude, around Vernal Equinox: during the half-hour (eq. 1) the solar disk requires to set, the solar declination will increase by about a half an arcmin.

Table 1: Solar Lower-Limb-Touch Horizon Azimuths Along 70°W

Date	Rise			Set		
	latd	LAT	Azimuth	latd	LAT	Azimuth
1909 Mar 21	85°26′N	5:30	+82°.4	85°33′N	18:42	−79°.4
1909 Mar 22	85°43′N	5:07	+76°.6	85°48′N	19:07	−73°.1

24′/day (or 1′/hour). Table 1 provides the solar azimuth at the horizon (i.e., rising or setting) at lower-limb-touch on the two equinox days mentioned, together with Peary's claimed latitude[10] (latd) and the local apparent time (LAT) when each event occurred. (For −40°F temperature,[11] the compact formulas of *DIO 2.1* ‡3 fn 17 find 48′ of refraction at the horizon, and that value is adopted for the discussions of this section, including Table 1.)

C2 The azimuth changes are so rapid just from morning to night that anyone wanting to adjust his compass via solar azimuth can certainly not be (as in Peary's §A1 note) blithely cavalier about which **day** to do it on.

C3 Moreover, for both dates (March 21 & 22), when the Sun was actually "due E. & W." (§A1), it was not rising or setting — to the contrary, every part of its disk was above the horizon by an amount exceeding that disk's diameter! In fact, as we see from Table 1, no part of the Sun contacted the horizon within 7° of "due E. & W." on either date.

D Horizon-Touching

D1 So much for the "accurate [equinox] check on compasses". Now to examine the matter of the sun allegedly just touching[12] the northern horizon on March 26 and March 27. This obviously refers to the time when the sun's lower limb is coincident with the horizon.[13]

D2 Peary's description (§A1) of the sun "touching" the horizon on March 26 *and* 27 is particularly noteworthy, since it requires that between those two dates he suddenly ceased his life's-obsession poleward march and — at double his usual daily speed — raced *southward* 24 nautical miles (nmi). (I.e., solar declination increased 24′ during the 24^h.)[14]

D3 The difficulty satirized by §D2 is this: the Peary expedition was claiming (e.g., Peary diary 1909 March 22) about 12 nmi (12′) per day, while the sun's declination was increasing almost 24′ per day; thus the sun's midnight altitude above the northern horizon was increasing in notches of about 36′ every day — an amount which is more than double the solar semidiameter (16′). The rapidity of the phenomenon therefore makes it unlikely *a priori* that a neat "touch" will occur. And, since the sun's entire 32′ diameter is less than 36′ it was not possible for an observer to see the solar disk intersect the northern horizon on *both* dates cited in the §A1 note. No adjustment of dates or refraction constants can change that essential fact.

D4 Let us take a closer look. At 0:00 LAT of 1909/3/26, solar declination $\delta = +1°57'$. With refraction 46′ (fn 16) and solar semidiameter 16′, we may easily find the latitude ϕ_b (along the 70°W meridian) where an observer could see the midnight sun's bottom (lower limb) touch[15] the horizon:

$$\phi_b = 90°\text{N} - 1°57' - 46' + 16' = 87°33'\text{N} \qquad (2)$$

D5 Table 2 supplies declination data at 0:00 LAT for March 26, 27, & 28, as well as (with 46′ of refraction)[16] the latitudes[17] (for those same times): touching and claimed.

D6 From Table 2, it is clear that for 0^h on 1909/3/26 & 3/28, the sun does not come anywhere near a touch — the entire disk goes well below the horizon on the former date, and well above it on the latter. At 0^h on 1909/3/27, the sun's center (not lower limb) would

Table 2: Peary's Position vs. Where the Sun Touches the Horizon

Date	Decl	Touching Latitude	Peary Latitude
1909/3/26	1°57′	87°33′	86°38′
1909/3/27	2°20′	87°10′	86°53′
1909/3/28	2°44′	86°46′	87°05′

[10] Table 1's sunset latitudes are found at Peary 1910 pp.338&352, respectively, while the sunrise latitudes are interpolations from these data and the Peary diary's travel schedule.

[11] Peary's diary entries for this time indicate a mean temperature of about −40°, for which, the *DIO* formulas yield refraction 48′.0. Subtraction of solar parallax makes $r\&p$ a bit less, but we will round to whole arcmin, given the uncertainty (fn 8) of near-horizon refraction.

[12] As elsewhere here, apologists may be temporarily tempted to try accenting the unevenness of the real rather than ideal horizon. But a moment's reflection will reveal that this factor brings much more harm than aid to the cause of defending Peary's note. (The theoretical horizon is simply the [great-circle] locus of points 90° from the zenith. For a person of normal height, dip would put a sea horizon at 90°02′ from the zenith, a trifling adjustment which is in any case wiped out by the roughness [and comparable height] of an ice-horizon.)

[13] However, assuming upper limb does not salvage the §A1 memo's credibility.

[14] More exactly: the mean daily variation of solar declination during the days under discussion here (March 26-28) was about 23′1/2.

[15] Due to declination-variation, the Sun's lower culmination here (c.87° 1/4 N) occurred, for a fixed observer, about 5^m before local apparent midnight. (A moment which, by chance, was almost exactly local mean midnight.) Thus, lower culmination was over 1° to the left of true north — and such a systematic error (intrinsic to the horizon-touch aiming-notion) will grow rapidly as one approaches the Pole (and will be larger yet if the observer is moving northward while detecting the touch: fn 18) as will the already disablingly-large random uncertainties indicated elsewhere here.

[16] During these days, Peary's diary makes the temperature about −30°F, for which *DIO* refraction (fn 11) is 46′.1 — and we again (*idem*) round to whole arcmin.

[17] Based on accounts of the expedition, as condensed in the valuable chart of adulatory biographer Wm. H. Hobbs (*Peary* NYC 1936 p.344 opp). The 86°38′N latitude is directly based upon R. Marvin's 1909/3/25 sextant sight (made about 1/2 a day before 3/26 00:00 LAT). The following days' figures were gotten by adding, to Marvin's figure, the Peary diary's often over-optimistic (see also Kane & Hayes) dead-reckoning march-estimates, 15 nmi & 12 nmi, respectively. (The 1909/3/28 camp's latitude was estimated as 87°12′N on p.262 of Peary 1910 and as 87°15′N at *ibid* p.338.) The next sextant sight (1909/4/1) showed that the expedition was 15 nmi south of where its exaggerated dead-reckoning estimates had placed it. The discrepancy was (diary & Peary 1910 p.268) blamed on wind. The diary dead-reckoning figures in nmi for the 5 marches between 1909/3/26&3/31 are: 15, 12, 12, 20, & 23 — total 82 nmi, vs. 67 nmi = difference of sextant sights (87°45′N − 86°38′N). Even accepting the shaky Bartlett sextant-sight at face value, this indicates a dead-reckoning exaggeration-factor of 82/67 or about 1.22; dividing that factor into the figures claimed for the 1st two marches and adding to 86°38′N, we find that 86°50′N & 87°00′N are more likely than Table 2's dead-reckoning-based estimates (86°53′N & 87°05′N) for Peary's actual respective 1909/3/26&27 latitudes. Such dreamy overestimates as 20 nmi & 23 nmi are accepted as real by Molett 1989 p.144, without noting the 1.22-factor discrepancy. The 20+nmi/march claims continued from there to the "Pole" camp (1909/4/6-7), during the allegedly-high-speed-though-unfortunately-not-verified final dash, where the trail was now hewn by Henson not Bartlett, even though Peary's 1906 diary scoffed at the former's drive (Rawlins 1991 §D4). Peary's opinion had not improved in 1909, when the 42-yr-old Henson was 3 more years past his exploring prime; see Peary 1910 p.240 and diary 1909/3/22 (similar to 3/23): "Henson still in his igloo as usual."

be about on Peary's horizon. (That is, the difference between the entries in the middle row of Table 2 is $87°10' - 86°53'$ = $17'$ which is about equal to the solar semidiameter.) The sun's bottom would spend over *three hours* beneath the horizon, while covering a range of azimuth of about 50°. Not very helpful to a navigator.

D7 Peary's diary for 1909/3/27 makes no claim that he set his compass by such lax means, nor does it state that the sun touched the horizon, merely noting:[18] "Sun did not set last night."

E Imaginary vs. Real Navigation

E1 A navigator with good eyesight might try locating lower culmination by repeated altitude fixes over more than one half hour, in a manner similar to the one discussed (for upper culmination) in the Navigation Foundation Report pp.55f. But, for latitude ϕ = 87°N, $180'$ from the Pole, if the sun's disk just disappears (at lower culmination) in the north (upper limb at horizon), then the azimuths A_t of the two points at which the $32'$-wide solar disk is touching the horizon (lower limb at horizon) are 35° on either side of the touching-point! For the polar regions, a crude calculation of A_t will be of sufficient accuracy:

$$\cos A_t = (180' - 32')/180' \tag{3}$$

An exact equation is:

$$\cos A_t = \sin\delta \sec\phi \sec h - \tan\phi \tan h \tag{4}$$

Eq. 4 (for δ = $1°58'$, refraction $46'$) yields the same result as eq. 3, namely, A_t = 35°. So, as noted, this method leaves an aiming slack of about ±35°.

E2 And attempting to estimate the midpoint by eyeball-gauging sunset & sunrise — as Molett 1989 proposes — runs into the same type of difficulty as we examined at §B4: the sun skims the horizon at such a gradual angle that it is a practical impossibility to determine when it "sets" or "rises".

[18] A dedicated apologist may wish to argue that Bob Bartlett, not Peary, was the observer of the alleged solar horizon-touching. (Though, Bartlett is not mentioned in the §A1 note.) Bartlett's trail-breaking party went ahead of Peary's main party (which was immobile at 0^h) late in the day on 1909/3/26. (It is clear from Peary's diary that Bartlett arrived at $87°05'$N [or less: fn 17] around the middle of 1909/3/27. [Not earlier than 10:30 AM, and probably later.] Thus, at the previous midnight, he cannot have been anywhere near $87°09'$N, the horizon-touching latitude of Table 2.) Assuming Bartlett was a few miles north of $86°53'$N will very slightly ease the $16'$ discrepancy (Table 2) for 1909/3/27 0^h — but not nearly enough to get rid of the main problem: the solar lower limb on the horizon not at true north but at two points some hours and many degrees apart. Also, if Bartlett is assumed in motion, then adding his 2 knots ($2'$/hr, the mean claimed sledging speed of the expedition) to the $1'$/hr declination-increase of the Sun makes a total of $3'$/hr linear motion superposed upon the virtually-quadratic lower culmination phenomenon — thereby throwing off (to the left) the position of solar lower culmination by about triple the previous estimate (fn 15): roughly 4°. (Thus, an observer sledging northward after 3/27 would have seen lower culmination about a quarter hour before local apparent midnight. Bartlett was traveling at midnight at this time. And Peary says he was, too, as he approached his alleged N.Pole camp.) Just one more indication that this entire approach is a somewhat imprecise aid to the determination of true north. I conclude with a compact approximate formula for the error E in solar-culmination-directed steering, where E is the distance in nmi leftward (midnight) or rightward (noon) of the North Pole one is seeking, if aiming toward (midnight) or opposite (noon) the point of observed culmination (latitude cancels out of the problem if it is expressed thusly): $E = 9 \sin\epsilon \cos\alpha + 11v/3$, where v = traveler's sunward velocity in knots, ϵ = obliquity of ecliptic, α = solar right ascension. (It is assumed that one is in the Arctic, and the tiny ellipticity of the Earth's orbit is ignored.) At midnight in early Spring, this becomes nearly $E = 3.6{\cdot}(1 + v)$; so, for Peary's claimed speed (v = 2 knots), E is over 10 nmi to the left of the Pole.

E3 Ordmag $1'$ is the smallest change in altitude h visible to the naked eye (even under ideal conditions — i.e., free of glare, irregular horizon, intermittent clouds, snowblindness, & the distractions of wearing travel); and rough calculation for latitude 87°N ($180'$ from the pole) shows that a $1'$ shift in h corresponds to an azimuth change ΔA near lower culmination of (analogously to eq. 3, ignoring refraction):

$$\Delta A = \arccos[(180' - 1')/180'] = 6° \tag{5}$$

Including differential refraction (based on *DIO 2.1* fn 17), we need $1'.3$ true altitude change at the horizon to produce $1'$ of change in apparent altitude h, so eq. 5 must be altered to:

$$\Delta A = \arccos[(180' - 1'.3)/180'] = 7° = 28^{\rm m} \tag{6}$$

Thus, for nearly an hour (1/2 hour either side of the "touch"), the sun's altitude h will vary by only $1'$, the discernment of which (even over a smooth sea horizon) would be close to the limit of human vision. (As one gets nearer the Pole, this time becomes greater yet.)[19]

E4 Of course, one could do better with a sextant, but no claim is made that this was used in connection with the §A1 note, and the expedition records contain no such sextant[20] observations. It is therefore a fair conclusion that the remarks in the Peary §A1 memo do not relate to instrumental observations.

E5 Incidentally, a much better and simpler way to navigate is by transverse[21] (E-W) observations via sextant. To estimate latitude ϕ, one may merely measure the difference

[19] ΔA is here about inversely proportional to the colatitude's square root. I.e., none of the navigational methods fantasized (by Peary's vanishing band of defenders) are successful in salvaging his claim because *all break down when closing in on the Pole* — which is, after all, slightly relevant to the process of getting there. (Navigators are urged to enjoy Nav Fnd Rpt p.58, which attempts to dance around — actually to invert — this self-evident truth.) See Rawlins 1973 p.114.

[20] As regards lead-sledger Bartlett (fn 18): he lacked a sextant when in the lead, since Peary's bringing-up-the-rear party carried the only sextant. (Which wasn't used before 3/22 noon: Peary 1910 p.248.) An overview reveals that modern defenses of Peary's steering uniformly slide past several obvious items. [a] Peary himself never explained it (even when under attack on the point: fn 2), a fact with exceedingly obvious implications. (And that is why his defenders have spent hundreds of pages attempting to invent methods for him — uniformly ignoring his suppression of his only diary statement on steering: fn 2.) [b] Again (fn 4, Rawlins 1973 p.143, 1992 fn 50 conclusion), where are the *written records* of Peary's alleged solar-based corrections of compass? (Notably: no such data in the §A1 memo!) [c] It is redolent of remote-fringe scholarship to propose that a highly capable explorer, carrying both sextant and theodolite on his sledge (Peary 1910 p.288 note) — which he used to steer all his previous trips — would for the first time in his career suddenly decide to forego such swift, accurate, tried&true methods and instead zero in on the Pole by eyeballing slow and erratic horizon phenomena. This is apology, not history. (For an extremely simple, nonconspiratorial explanation of how Peary was forced into claiming no sextant steering data, see Rawlins 1973 pp.114, 144, 149-150: briefly summarized here at fn 2.) [d] And if, as all apologists claim, Peary was right to eschew transverse observations (*en-route*) in 1909, then: why did he use precisely such data (Nav Fnd Rpt pp.221-222) at the "Pole" camp, 1909/4/7 6 AM (70°W time, 6:40 AST)? (Another way of expressing this key difficulty with Peary's 1909 navigational story: why take the best [§E5: factor of 20] type of steering observations only *after* arrival at the point one was steering for?! See Rawlins 1973 pp.114 & 149.)

[21] It is not required that transverse sextant shots be on the prime vertical in order to steer by them. (But §E5's method makes the navigational math easier.) In any case, some sort of transverse sextant observations were the standard method Peary and other explorers used for steering at a pole. Despite this, the Navigation Foundation (hired consultant to National Geographic, which used to boast it established its international renown by certifying Peary's claim: Rawlins 1973 p.190) prominently asserted that, since Amundsen hit the South Pole (1911) without tranverse sextant solar shots for longitude, then Peary could have done likewise. (See *National Geographic Magazine* 1990 Jan p.47, and Nav Fnd Rpt pp.61-62.) But then Ted Heckathorn discovered proof that Amundsen of course *had* used standard transverse observations for aiming at the S.Pole. See Rawlins 1992, the *DIO 2.2* paper

between observed and assumed E or W altitudes h to find orientation, or monitor the rate of ascent or descent. The altitude h_o of the sun on the prime vertical (E or W) is given by:

$$\sin h_o = \sin\delta / \sin\phi \tag{7}$$

Ephemeris tables provide the precise declination δ, and a noon reading gives latitude ϕ. With a log-trig table (and a page or two from each table will suffice), it is easy to compute-predict h, so one simply watches by sextant until the sun has attained that value. The sun is then due east or west. The precision is much superior to the N-S method (§§E1-E2). Ignoring small variations in δ and in the equation of time, the ascent-rate dh/dt is just:

$$dh/dt = \dot{h} = \cos\phi \sin A \tag{8}$$

where A = azimuth; so, near the prime vertical, the sun's rate of ascent $\dot{h}_o$ is virtually:

$$\dot{h}_o = \cos\phi \tag{9}$$

In our earlier example (§E1), ϕ = 87°N, so $\dot{h}_o$ = 1/19 — i.e., 1′ of altitude change will correspond to 19′ of time or azimuth instead of 7°. The precision is improved by a factor[22] of about 20. Near the poles, the eq. 7 method is not very latitude-sensitive either, since $\sin\phi$ is effectively constant (at unity) near the North Pole.

E6 The conclusion must be that at best the §A1 memo is an uncertain later reconstruction from memory, not a record of actual observations for navigation, nor a description of superior methods. Whether this should influence the evaluation of Peary's claim to have reached the North Pole must depend on weighing the total evidence.

References

Mohn, H.: *Roald Amundsen's Antarctic Expedition, Scientific Results. Meteorology*. Videnskapsselskapets Skrifter. 1. Mat.-naturv. Klasse (1915, #5).

Molett, W.: *Analysis of Admiral Peary's Trip to the North Pole*. Navigation 36.2 (1989).

Navigation Foundation Report [Nav Fnd Rpt] (1989): *Robert E. Peary at the North Pole*. Report to the National Geographic Society by the Foundation for the Promotion of the Art of Navigation (1989/12/11).

Peary, Robert: 1909 Diary. US National Archives official microfilm [1971].

Peary, Robert: *The North Pole*. Stokes, New York City, 1910.

Rawlins, Dennis: *Peary at the North Pole, Fact or Fiction*. Luce, Washngtn DC, 1973.

Rawlins, Dennis: *Peary, Verifiability, & Altered Data*. DIO 1.1 ‡6 (1991).

Rawlins, Dennis: *Amundsen's "Nonexistent" South Pole Aiming Data*. DIO 2.2 (1992).

which triggered the *Wash Post* 1993/6/1 article which itself caused the skeptical 1993/6/11 story in *Science* (Amer Assoc Adv Science). [Note added 1997/3/10: NGS' Pole myth has since evaporated in the scientific community. (See also Rawlins 1992 fn 2 & *DIO 2.3* ‡8 fn 11.) More hits on it will soon risk SPCA-wrath at deadhorse-abuse. NGS greeted Bryce (fn 22) with standard-slowbleed p.r.: the-controversy-will-continue. DR (1991/8/13 *Wash Post*, emph added) on the same mantra: "Needless . . . . [NGS] should . . . have Admiral Peary's claim and the [1989-1990 Nav Fnd Rpt] evaluated by the National Academy of Sciences, just as papers are routinely refereed every day in US science. **I am willing to abide by the Academy's evaluation. Is National Geographic?**" Silence. . . . *Finis*.]

[22] This ratio (the factor by which E-W sights are superior to N-S ones for steering) should probably be doubled (§E3), since culmination-time would (in 1909 field practice) be determined by equal-altitudes. (Claiming better eyesight [than 1′] will only increase the ratio, which is about proportional to the inverse square root of the acuity proposed.) [Note added 1997/3/3: R.Bryce's invaluable new book *Cook&Peary* . . . (1997) produces at p.420 another Peary memo on steering. Written for the mathematician whom Peary hid at home (before producing his "data"), it shows that, in 1909 Oct, Peary didn't yet know if he could trust the very steering method (sextant-gauged upper culmination) NavFou says (§E1) Peary confidently used **6 months earlier** to effect his miraculously-aimed Pole-in-one. Naturally, he never publicly claimed using such an inferior method. (So this was just another passing shade in Peary's chameleonic spectrum of pathetically-transparent-afterthought stabs at explaining his steering. Other hues: [a] §A1; [b] Rawlins 1991 §C6; [c] *ibid* §§C2&D7 vs. Peary 1910 p.211.)]