Document 1521C2

Magellan's voyage—A study of Magellan's route across the Pacific

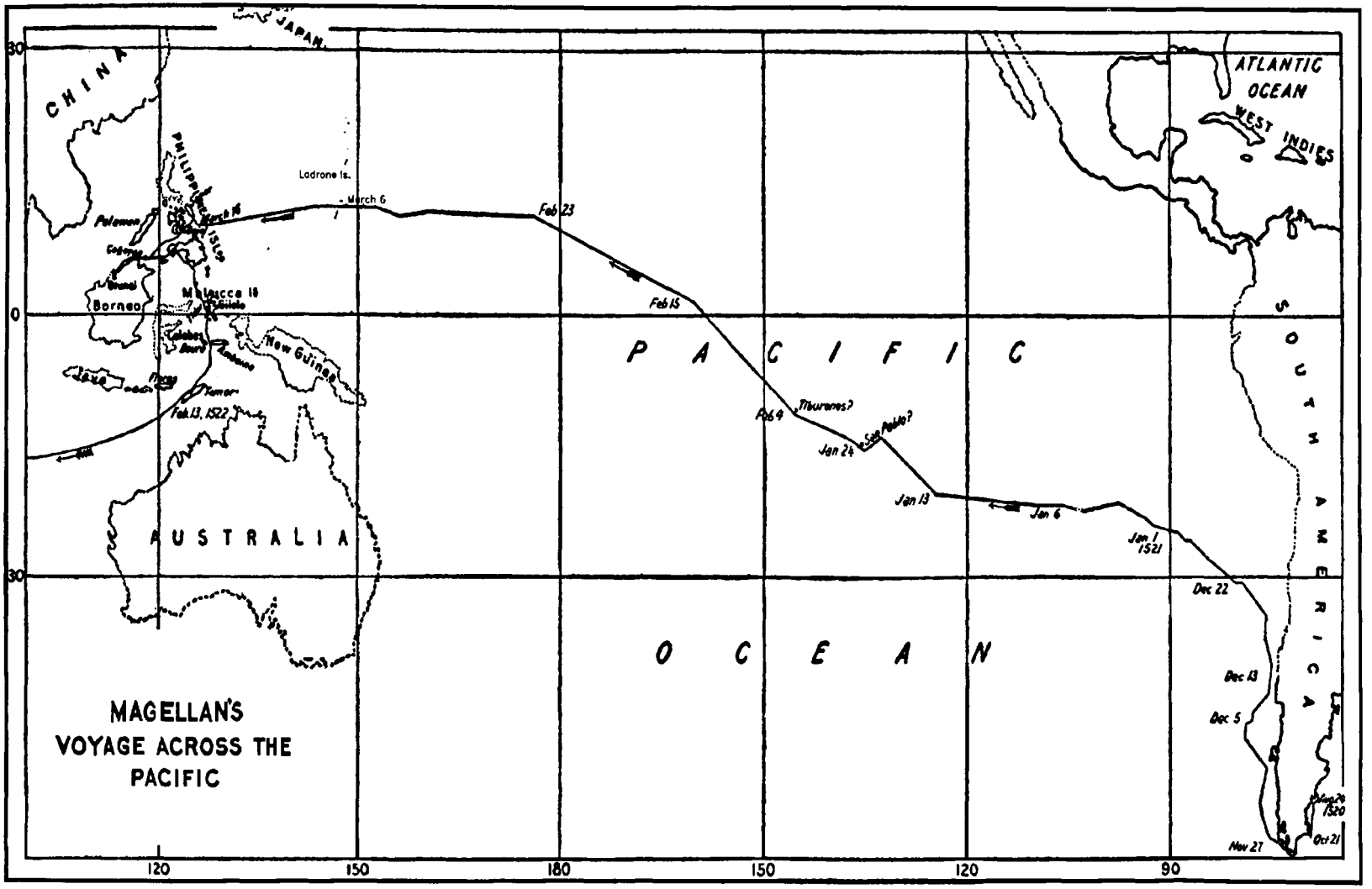
Sources: Alvo's logbook (See Doc. 1521C1) and previous studies by the following authors: 1. George E. Nunn, "Magellan's Route in the Pacific", in ***Geographic Review****, 24 (1934), 615-633; 2. H. E. Maude, "Spanish Discoveries in the Central Pacific; a Study in Identification", in the* ***Journal of the Polynesian Society****, 1959; 3. José Luís Morales, "Las derrotas de Magallanes y de Elcano en el primer viaje de circunnavegación", in Texeira da Mota (ed.),* ***A viagem de Fernão de Magalhães e a questão das Molucas*** *(Lisbon, 1975), pp. 343-360.*

Modern set of positions

From Alvo's logbook, which contains headings and observed latitudes for almost every single daily run in the Pacific Ocean, Magellan's route throughout the Pacific can be charted on a modern chart. Hence, the identification of the reef islets he called the Unfortunate Islands can be determined with some measure of accuracy. In the Museo Naval in Madrid, there is a file created in 1856 (ms. 96, fol. 258-260); it is an unconclusive analysis of Magellan's route made by the former Director of the Depósito Hidrográfico in Cádiz.

Without considering the effects of currents and magnetic deviations, Alvo's positions were converted to regular readings of latitudes and longitudes that can be plotted on a modern chart. This last part of the work was carried out by José Luís Morales for the second symposium on overseas history held in Lisbon in 1973.

The following data is based on Morales' published article; I have amplified his list of positions to include all daily positions given by Alvo, converting Morales' longitudes from W. of Cádiz readings to W. of Greenwich (by adding or subtracting 6°17' which is the difference between these two meridians). Morales has simply deducted his coordinates from the intersections of parallels expressing latitudes with successive headings. The only adjustments Morales did apparently was to take into account the known positions of one or more features along the Chilean coast and that of Guam. Hence, his longitudes in mid-Pacific seem to be off by 2-5 degrees.



MAGELLAN'S VOYAGE ACROSS THE PACIFIC

(Facing page) **Magellan's track across the Pacific**. *The most probable track has been plotted using the positions in Alvo's logbook. Note the two Unfortunate Islands discovered on January 24, 1520 (San Pablo which seems to be Pukapuka), and on February 4, 1521 (Tiburones which can be one of three reef islets: Caroline, Flint or Vostok). Thus, by a stroke of gook luck, the Magellan Expedition missed stumbling upon the major shoals of the Pacific: the Tuamotus, the Gilberts, the Marshalls, the Carolines, etc. (From John Fiske's "The Discovery of America", vol. 2)*

Approximate Plot of Magellan's Run across the Pacific

Date	Latitude	Longitude	Remarks
27 Nov	52°43'	74°42'W	Coming out of the Strait, in 1520.
29 "	50°55'	77°57'	Date not specified by Morales.
30 "	50°09'	77°57'	id.
1 Dec	48°00'	76°37'	
2 "	47°15'	76°07'	
3 "	46°28'	77°17'	Alvo says Lat. 46°30'
4 "	45°30'	78°45'	
5 "	44°15'	79°07'	
6 "	44°00'	78°	Position not given by Morales.
7 "	43°40'	77°47'	
8 "	43°15'	77°29'	
9 "	42°40'	77°08'	
10 "	42°12'	---	id.
11 "	41°40'	---	id.
12 "	41°15'	75°32'	
13 "	40°00'	75°10'	
14 "	38°47'	75°09'	
15 "	38°00'	74°57'	
16 "	36°30'	75°09'	
17 "	34°30'	76°32'	
18 "	33°30'	76°'35'	
19 "	32°45'	77°37'	
20 "	31°45'	---	id.
21 "	30°40'	80°07'	
22 "	30°40'	83°07'	Morales' latitude of 31°15' is wrong.
23 "	30°00'	85°47'	
24 "	29°45'	---	Position not given by Morales.
25 "	29°30'	87°57'	
26 "	28°45'	87°44'	

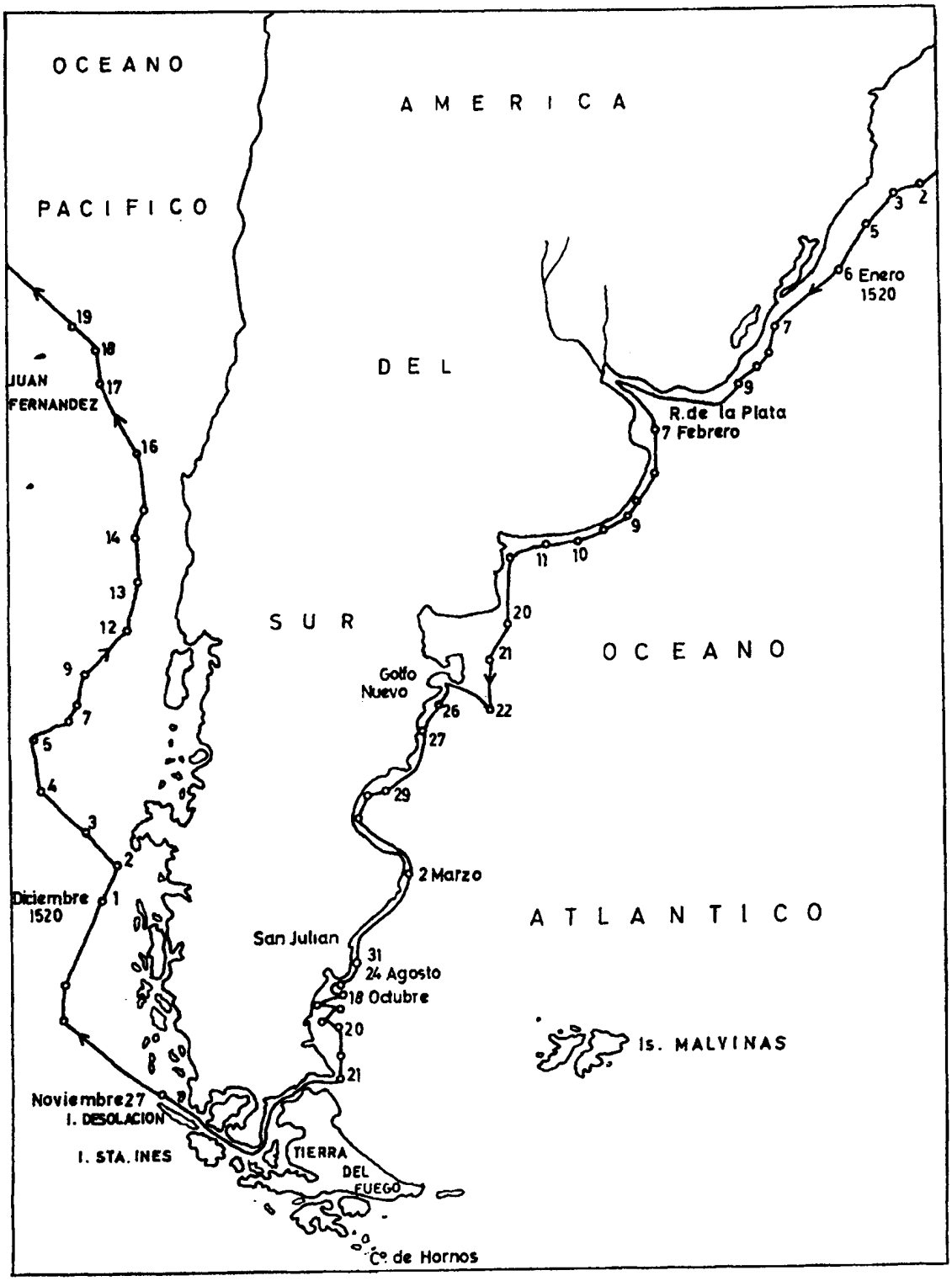
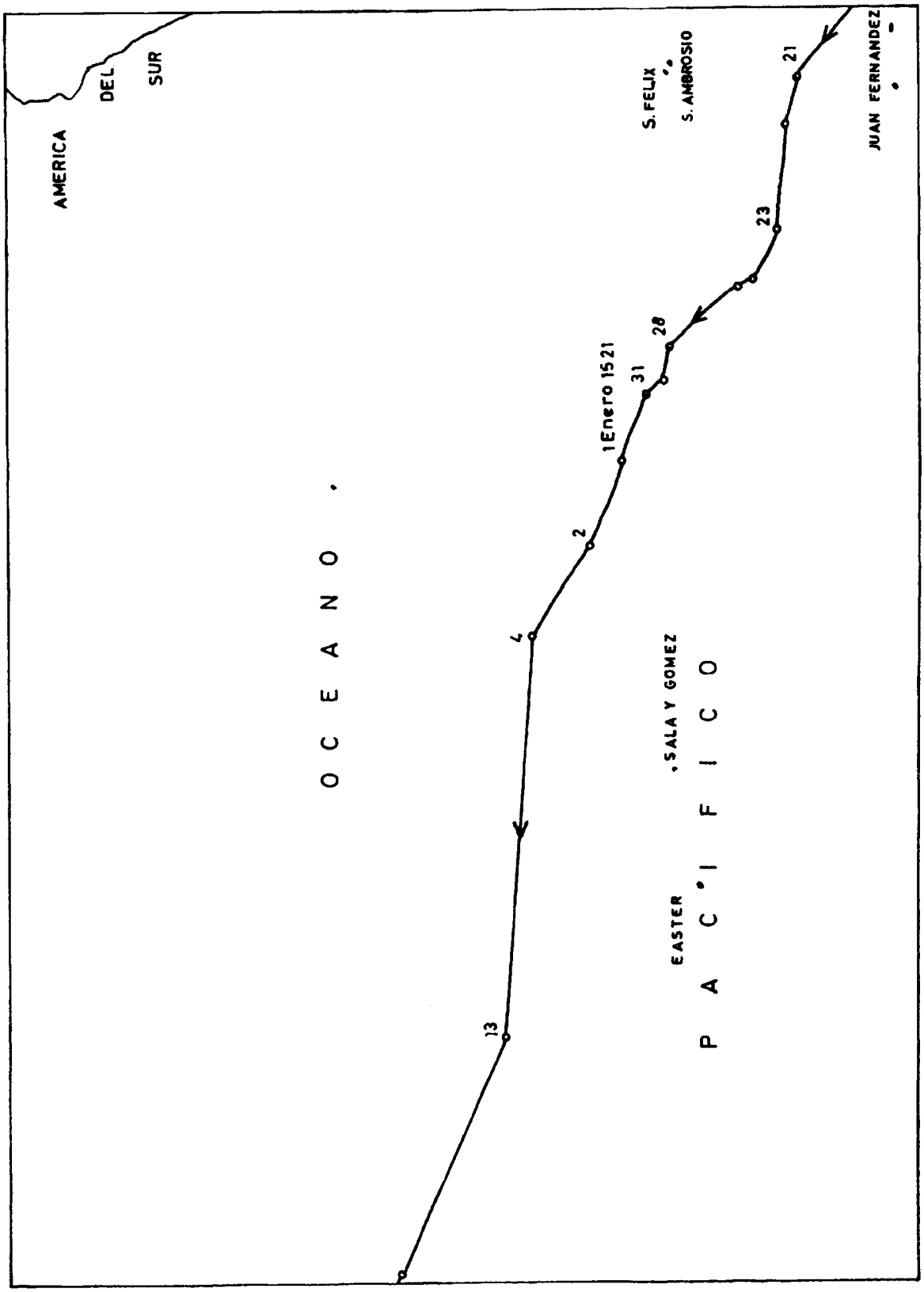


Plate 3 of Morales (See Sources above).

27 "	27°45'	---	Position not given by Morales.
28 "	26°45'	90°03'	
29 "	26°20'	90°32'	
30 "	26°20'	91°07'	
31 "	25°27'	91°47'	
1 Jan	25°00'	92°17'	Year 1521
2 "	24°00'	97°07'	
3 "	23°30'	---	Position not given by Morales.
4 "	21°57'	100°22'	
5 "	23°00'	---	id.
6 "	22°00'	---	id.
7 "	22°00'	---	id.
8 "	22°00'	---	id.
9 "	22°15'	---	id.
10 "	22°00'	---	id.
11 "	21°45'	---	id.
12 "	21°20'	---	id.
13 "	21°05'	114°37'	
14 "	20°30'	---	id.
15 "	19°30'	---	id.
16 "	19°00'	---	id.
17 "	18°15'	---	id.
18 "	17°33'	123°07'	
19 "	16°15'	---	id.
20 "	15°00'	127°20'	
21 "	15°40'	---	id.
22 "	16°45'	---	id.
23 "	16°30'	---	id.
24 "	15°23'	133°40'	Position of **San Pablo**.[1]
25 "	15°45'	---	Position not given by Morales.
26 "	15°20'	---	id.
27 "	15°08'	135°40'	
28 "	14°30'	---	id.
29 "	13°45'	137°57'	
30 "	13°30'	---	id.
31 "	13°15'	140°40'	
1 Feb	13°00'	---	id.

1 Ed. note: Morales' position for **San Pablo** [= Pukapuka?]. Probable deduction from Alvo's logbook: 16° S. approximately. According to José de Espinosa's map, published in London in 1812, the longitude would be approximately 133°32' W. of Greenwich.



Place 4 of Morales.

2 "	12°30'	---	id.
3 "	11°45'	---	id.
4 "	11°15'	142°47'	Position of **Tiburones**.[1]
5 "	10°00'	---	Position not given by Morales.
6 "	9°15'	---	id.
7 "	8°45'	---	id.
8 "	7°40'	146°34'	
9 "	6°30'	---	id.
10 "	5°00'	---	id.
11 "	2°30'	---	id.
12 "	1°00'S	153°50'	Morales' latitude 0°05' is wrong.
12-13	0°00'	153°57'	**Crossing of the Equator**.[2]
13 Feb	0°30'N	---	Position not given by Morales.
14 "	1°00'	---	id.
15 "	1°40'	155°57'	id.
16 "	2°30'	159°17'	Morales' latitude 3° wrong.
17 "	3°35'	161°17'	
18 "	5°00'	---	Position not given by Morales.
19 "	5°40'	---	id.
20 "	6°30'	---	id.
21 "	7°55'	173°07'	
22 "	9°30'	176°47'W	
23 "	11°30'	---	id.
24 "	12°00'	---	id.
25 "	12°20'	---	id.
26 "	12°00'	---	id.
27 "	12°00'	---	id.
28 "	13°07'	164°40'E	
1 March	13°00'	---	id.
2 "	13°00'	---	id.
3 "	13°00'	---	id.
4 "	13°00'	---	id.
5 "	13°00'	---	id.
6 "	13°48'	144°43'	Position given by Morales.
6 "	13°00'	146°	Approx. position when **Guam sighted**.

1 Ed. note: Position of **Tiburones** [= Flint?] as given by Morales and Espinosa. Latitude given by Alvo is 10°40'S.

2 Ed. note: Position given by Morales. It was 166°W according to Koelliker, so 160°W would be a compromise.

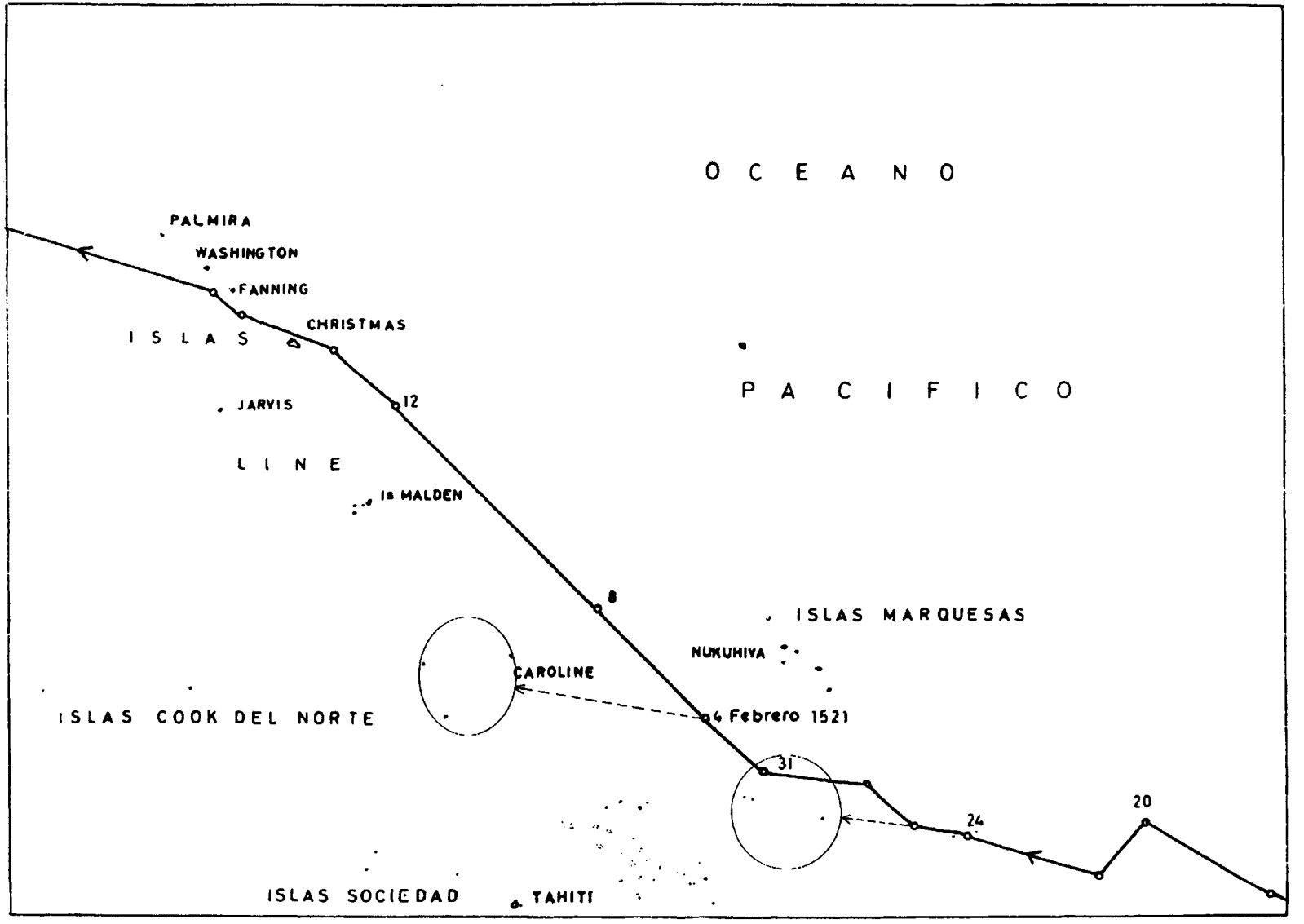


Plate 5 of Morales.

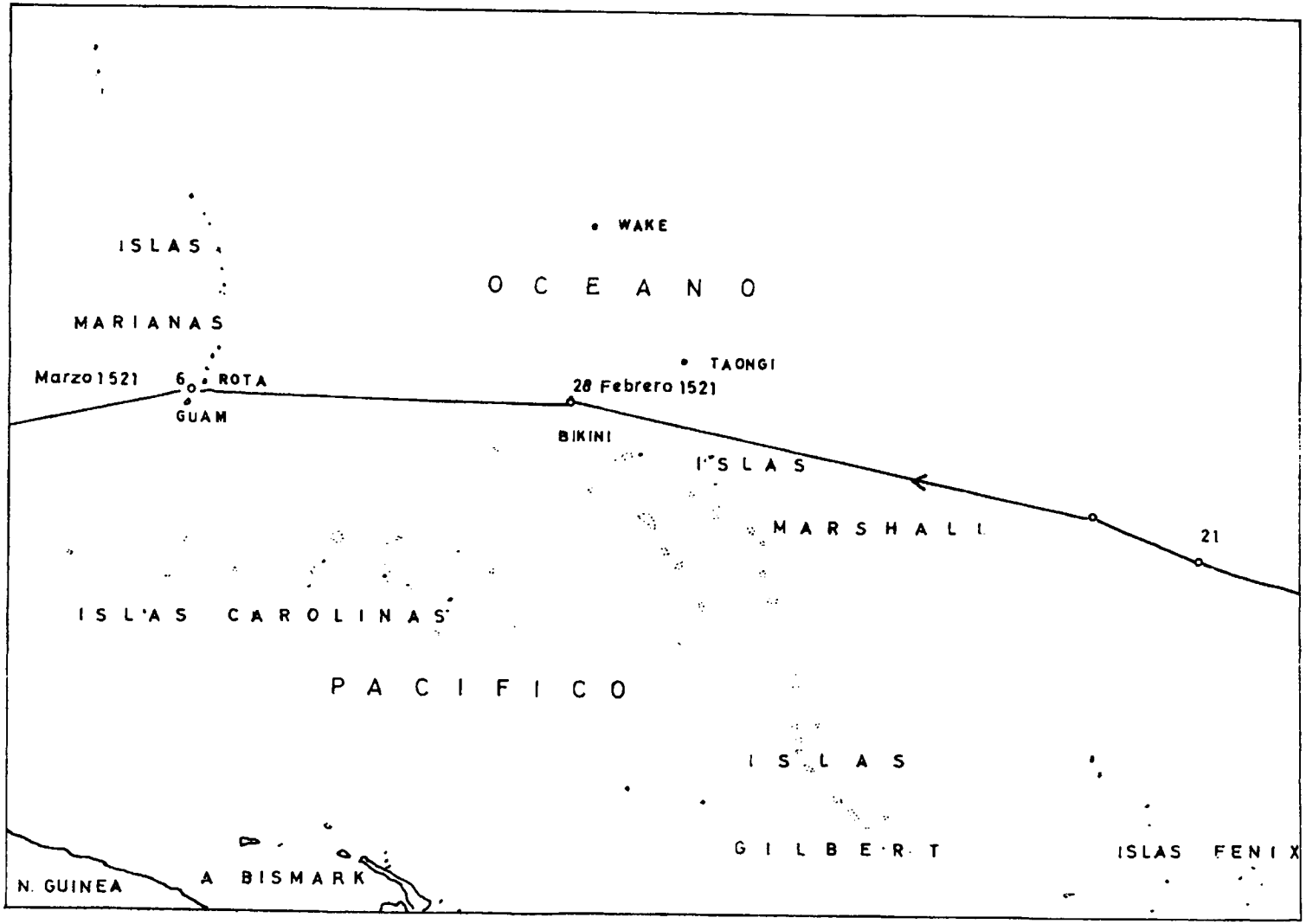
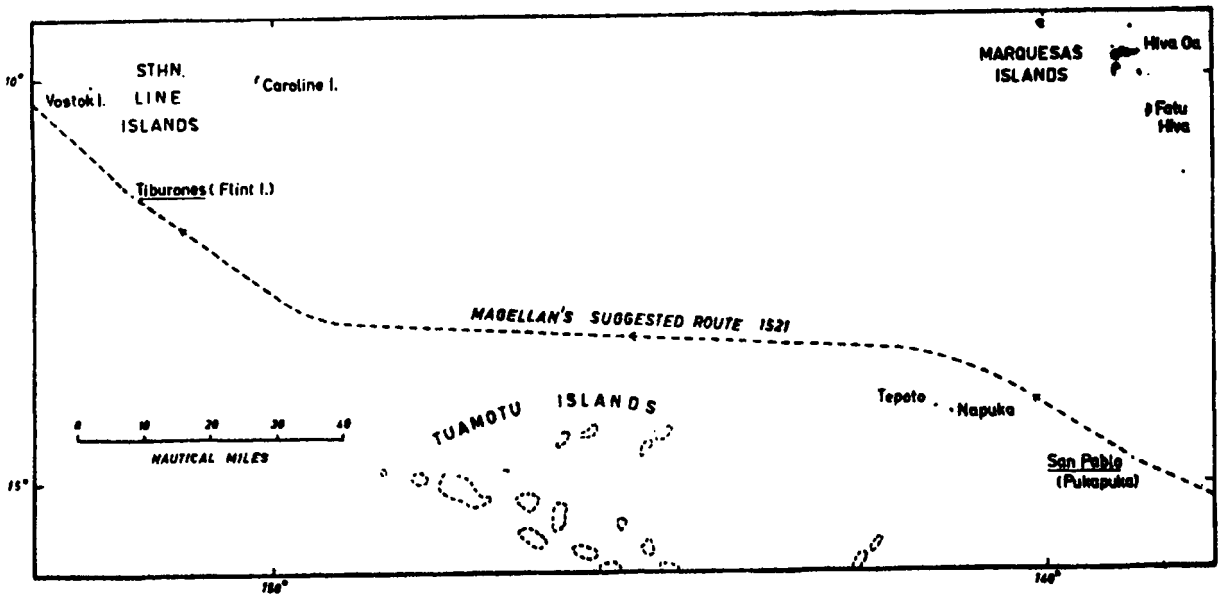


Plate 6 of Morales.

-	12°	145°	Approx. position of S. part of Guam.
9 "	12°40'	---	Position given by Alvo [= Umatac?]
...			
16 "	10°00'	---	Latitude of **Yunagan**.[1]



Maude says Pukapuka is San Pablo and Flint is Tiburones.

1 Ed. note: Latitude of Yunagan [= Guiuan], Philippines. It is closer to 11°. From the known position of Rota, Guam, and Guiuan (Samar), we deduce that Alvo's latitudes (above) were consistently about 1 degree too low while at sea, and 40 minutes too low while at anchor. Those are excellent results for the times, considering the probable inadequacy of his almanach.

Review of Maude's article

I agree with this author that *"throughout the period of the Spanish discoveries the calculation of longitude was hardly possible, except by the often inaccurate method of estimating from dead reckoning."* However, I do not entirely agree with him when he says that *"under the easy wind and weather conditions prevailing in the region the latitudes obtained can be relied on to within at any rate two or three degrees."* This margin of error would perhaps occur while at sea, but on land or when anchored, the latitude readings of the early Spanish pilots in the Pacific have consistently and remarkably been within one degree, a fact confirmed by modern marine charts for known locations.

Maude continues: *"In a few instances the identification of one island is at least partly dependent on that of another, and for this reason it proved necessary to establish the identity of Magellan's* ***San Pablo****... before proceeding to fix that of* ***Tiburones****... But here it must be confessed that the process of resolving the puzzle as to which Pacific island was the first seen by European eyes had its own satisfaction."*

He goes on to say that *"the various attempts which have been made to trace Magellan's route from the log show a remarkable similarity in their general outline, and all I have seen take him to the north of the Tuamotus and thence in a north-west direction between the widely spaced islands of the Line Group. Indeed, any deviation would have either brought him within sight of the mountainous islands of the Marquesas, visible for a considerable distance at sea, or else lost him in the intricate maze of the Tuamotu Archipelago."*[1]

Maude continues: *"...Owing to the greater accuracy of the positions given by Albo over the often hearsay estimates of the other informants, our islands are likely to be situated not much more than a degree on either side of his latitude. Unfortunately, Albo gives the latitude of Tiburones but not of San Pablo, but taking this latter as the mean between his sights on January 24 and 25, or 16° S, we can expect San Pablo to be somewhere between 15° and 17° S and Tiburones between 9°40' and 11°40' S... One island, and one only, satisfies our criteria [for San Pablo] to a nicety:* ***Pukapuka****, in latitude 14°50' S and longitude 138°50' W*[2]*. ... But if Pukapuka is San Pablo, we should be able to find the second of the Unfortunate Islands by sailing for approximately a further 200 leagues*[3] *on the same courses that Albo took: and such a voyage will in fact bring us to the Manihiki group or Southern Line Islands of Caroline, Vostok and Flint..."*

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1 First of all, the attempt made by Nunn is an exception, but as we shall see, his theory is not acceptable. The intricate maze of the Tuamotus did indeed pose a real problem; witness the story of the **Lost Caravel** by Robert Langdon (Sydney, 1975).

2 Ed. note: Maude used British Admiralty Chart N° 783 for these readings. Koelliker gives the position as 14°15'S and 138°48'.

3 Ed. note: As given by Pigafetta. Alvo had written a distance estimate, but numerous copyists have modified this figure or made transcription errors: 9 degrees, 9 leagues, etc.

"Which then of the three islands is Tiburones? From their position it could almost equally well be Caroline, Vostok or Flint; or, as in the case of many other identifications, we must turn to the internal evidence offered by the islands themselves..."

Caroline, in 10° S, is not a good candidate for Tiburones, according to Maude, because he thinks that it might have been inhabited at that time and that its shape as an atoll would have been reported.[1] However, the Morales track which, based on the actual position of Pukapuka, has been drawn 5° too far east, Caroline appears at first as a strong candidate for Tiburones. What does rule it out is the fact that the expedition would have run into Malden and Jarvis afterwards...

Vostok, in 10°05' S, is too small to be a candidate for Tiburones according to Maude. However, that is no reason to exclude it. I would not rely off-hand on the secondary account by Transylvanus to include or exclude Vostok as a possibility, because if one does so, the pair of islands Napuka and Tepoto, shown on Maude's chart (see above) would fit Transylvanus' description very well.

Flint, in 11°25' S and 151°48' W, is a better candidate according to Maude. However, I say that Vostok and Flint are equally good candidates, if one considers that their presence along Magellan's track would have resulted in the ships not hitting any of the other islands of the Line Group. However, if one considers Alvo's difference in latitude between San Pablo and Tiburones, about 5°20', then if Pukapuka is San Pablo, Vostok is therefore the better possibility, because the difference in latitude between Pukapuka and Vostok is closest to Alvo's 5 degrees plus.

We can unfortunately rely neither on Alvo's nor on Pigafetta's differences in longitudes, be they 9 degrees, 9 (or even 90) leagues, or 200 leagues...

I agree, however, with Maude when he concludes: *"It should be emphasized that the identification of Tiburones with Flint does not necessarily depend on San Pablo being Pukapuka. As far as latitude goes, San Pablo could be any one of the uninhabited islands of the north-eastern Tuamotus, and there are others at approximately the right distance and direction from Flint. For Pukapuka as San Pablo there are, then, admittedly alternative possibilities, if Magellan could have reached them without hitting, or at least sighting, some other island in the process, which seems doubtful; but for Flint as Tiburones there is really no alternative wherever one looks."*

By the same token, I say, for Vostok as Tiburones the possibility remains that Napuka and/or Tepoto might correspond to San Pablo. So, to conclude, in the San Pablo "circle" of possibility we have 3 islets: Pukapuka, Napuka, and Tepoto, and in the Tiburones "circle" we have 3 islets also: Caroline, Vostok, and Flint. We have, therefore,

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1 The fact that no lagoon was reported, but sharks were, has led Samuel Morison to favor Caroline I., because *"it is common knowledge in the Pacific that lagoons attract sharks"* (p. 412 of his **Southern Voyages**).

nine possible answers, that is, 9 possible pairs of islets. The most probable pairs, by decreasing order of relative importance, in my judgment, are:

1. Pukapuka—Vostok;
2. Pukapuka—Flint;
3. Napuka—Vostok;
4. Napuka—Flint.[1]

Supplementary evidence

To help the reader make up his own mind, the following points are presented for consideration:

1. Is it possible that Alvo's stated distance between the two landfalls is really 9 degrees **in longitude**, as stated in Navarrete's transcript? Morales's difference in longitude is also 9 degrees, and the manuscript in the Museo Naval has computed this difference as 8°39'. If so, Pukapuka would be more easily paired with Caroline, and Napuka with Vostok.

2. If any credibility can be given to the distance stated by Pigafetta, 200 old Spanish leagues, this corresponds to 200 x 4.23 km/league = 846 km, and since 1 nautical mile = 1.85 km, this distance corresponds to 846/1.85 = 457 nautical miles, which cannot be so accurate, but rather let us say 450 nm, plus or minus 50 nm. Even so, this is far off 8 or 9 degrees difference in longitude, as 9° x 60 nm/degree = 540 nm approximately, and should be greater, not less, as it is supposed to be a NW or hypothenus distance, rather than simply that of the base of a triangle.

3. **The variation of the compass.**—At sea the compass swings as the ship rolls, pitches, and yaws, and the only way to check its accuracy is to take it ashore. Nevertheless, the variation of the compass, that is the difference between magnetic and true north, was already well known, if little understood, in Magellan's day. The amount of variation was readily found by comparing the bearing of the North Star or Southern Cross, with the compass north. The Genoese pilot (See Doc. 1521D) tells us that this variation reached "almost two-quarters to the NW", i.e. almost two points (2 x 11°) or about 20° W while crossing the Pacific.

4. As for the influence of winds and currents, in the Line Group area of the Central Pacific, the prevailing winds were favorable and would have resulted in a greater than average daily distance covered; the predominant currents in that area to the south of

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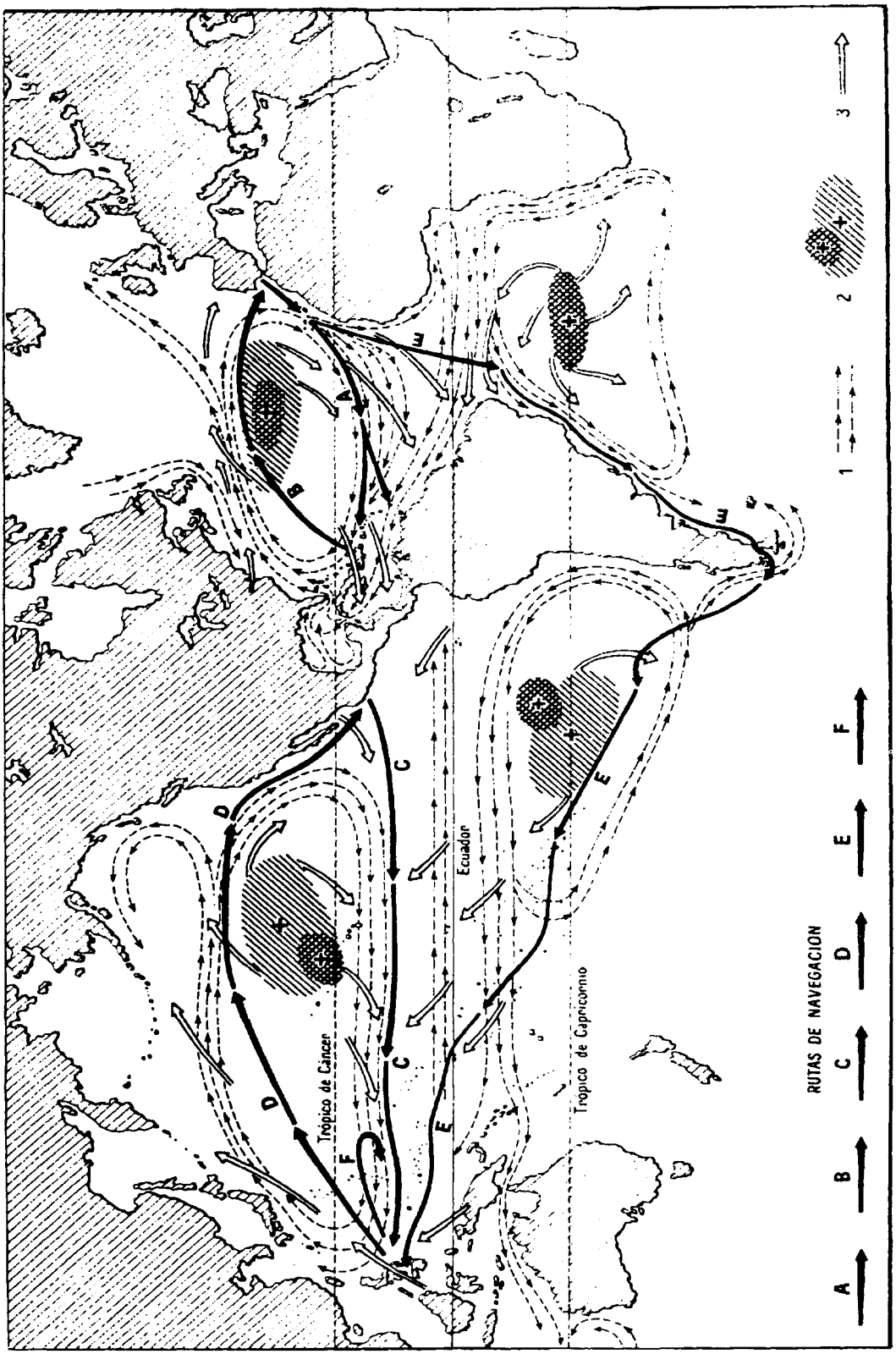
1 Other authors have also proposed alternatives to Pukapuka as San Pablo. Two of them are Sharp (see remarks below) and O. H. K. Spate (pages 47-48, **The Spanish Lake** , 1979). They have placed the Tuamotu outlying islets of Angatau and Fangahina (SW of Pukapuka) in the San Pablo "circle", thus replacing Tepoto and Napuka. The controversy continues...



the equator run E to W and they would have resulted in some westerly drift, which Morales has obviously not taken into account.[1]

(Facing page) **The great routes of navigation during the period of Spanish discovery (1492-1529)**, *showing: 1) the maritime currents and their directions, 2) the zones of high atmospheric pressure (which vary slightly in location between summer and winter), 3) the prevailing winds and their directions. Route E is that followed by Magellan across the Pacific. (Chart by Instituto Cartográfico Latino).*

5. **Nunn's theory**.—This writer rejects the standard track between the Tuamotus and the Marquesas. Instead, he claims, preposterously, that Magellan proceeded much farther north, almost as far as Mexico, before turning westward. Nunn's theory is that Alvo's logbook was falsified and that "the latitude of San Pablo and Tiburones was altered to south latitude" from north; hence, his conclusion that "San Pablo and Tiburones may be identified with Clipperton and Clarion Islands, in latitudes 10°17' N, and 18° N."

(Overleaf) **Magellan's route in the Pacific according to Nunn (1934)**. *His disregard of the primary evidence provided by the logbook (Alvo) and the eyewitness account of Pigafetta, and his reliance on secondary and tertiary historical accounts has led him to unacceptable conclusions.*

6. **Sharp's opinion**.—In his well-known book: **The Discovery of the Pacific Islands** (Oxford, 1960), Andrew Sharp expressed the following opinion:

"The only islands which conform with Albo's detail of the two islands south of the equator are either Fangahina or Angatau or Pukapuka for San Pablo, and Caroline Island or, less probably, Vostok, for Tiburones. Fangahina, Angatau, and Pukapuka are in the north-eastern sector of the Tuamotu Archipelago, their latitudes being 16, 15-3/4, and 14-3/4 degrees south respectively. Raroia and Takume, to the west of Angatau, being two islands close together, may be ruled out, since Albo's details indicate that the island in question was seen in close quarters. Caroline Island and Vostok are two isolated islands close to latitude 10 degrees south some 600-odd miles beyond Fangahina, Angatau, and Pukapuka. Caroline Island has a bay on the western or lee side from the south-east trade wind, and is noted for its fish."[2]

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1 Thomas Keller of Harvard University plotted the data in Alvo's log for Samuel Morison, subtracted up to 10°E from his courses, to account for compass variation, and this plot went by Pukapuka and Caroline Islands... Thus, by cutting in half the actual 20°E variation (given by the Genoese pilot), they more or less consciously have compensated for the unknown drift factor.

2 Ed. note: According to the **Pacific Islands Pilot** , vol. 3, pp. 201-2.