PRELIMINARY RESULTS OF DRIFT-BOTTLE RELEASES AND RECOVERIES IN THE WESTERN TROPICAL ATLANTIC

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SYNOPSIS

In February-March 1963, during the Equalant Operation for the ICITA program, 476 drift-bottles were released at the equatorial waters off the northern Brazilian coast (01°S to 09°N and 043°W to 053°W). Thirty-five bottles were recovered (7,4%). Those were classed in five groups according to their different velocity ranges and areas of recovery (Trinidad Island; Lesser Antilles; Caribbean and Florida area; north Brazil; northeastern Brazil).

The recoveries of bottles released within 300 nm off the northern and northeastern coast of Brazil confirmed a strong current along the north and northeast coast in northwestern direction (South Equatorial Current and branches). In late February-early March the bottles showed maximum velocities of this current (3,6 knots).

The region off the northern coast of Brazil, between 05°N and 09°N up to 050°W seems to have been under the influence of an eastward component of the surface current in this same period, while at late March this influence appears to have been weaker. In the region from Trinidad Island to Yucatan Peninsula the current seems to be stronger on the northeastern side of the Caribbean Sea.

INTRODUCTION

The present paper reports the preliminary results of the recoveries of drift bottles released during two cruises of the CT "Bertioga" to the Equatorial waters of northern Brazil undertaken as part of Equalant Operation ICITA programme, during February-March, 1963. A total of 476 bottles were released and 35 were recovered so far. Although the recoveries are rather limited, it is believed that their study may contribute to gain further knowledge of the surface currents of the region of North Brazil and the Caribbean Sea.

THE AREA STUDIED

The stations at which bottles were released during cruise A and B were located off the northern coast of Brazil in an area comprised approximately between 01°S and 09°N and 043°W and 053°W (Fig. 1 and 2). A total of 396 bottles were released during these two cruises, 10 at each station *. When steaming southward after cruise B another 80 bottles were released at stations situated off the northern and northeastern coasts of Brazil, covering the area between 02°S and 17°S and 040°W and 035°W (Fig. 2). On Figures 1-5 we have used a conventional successive numeration for all stations (48) from which drift bottles were released. Instead of drawing the probable routes of the recovered drift bottles on the maps, we preferred to identify the places of recovery with the same number as that of the respective release station. Tables VIa, VIb, and VIc give the date of release and recovery.

The literature concerning the investigated area describes it as follows: the current system of this area is essentially a continuation of the strong North and South Equatorial Current System. It is defined by DIETRICH & KALLE (1957) as a region of tradewind currents. From December to about late February, when cruise A was carried out, the northern trade wind system attains in that area its southernmost limit from about 01°N and 030°W up to about 07°N and 050°W, off the northern coast of Brazil up to the Guiana coast. The northern limit of the southeast trades runs approximately along the Equa-

* With exception of station 11 where only 6 bottles were released.
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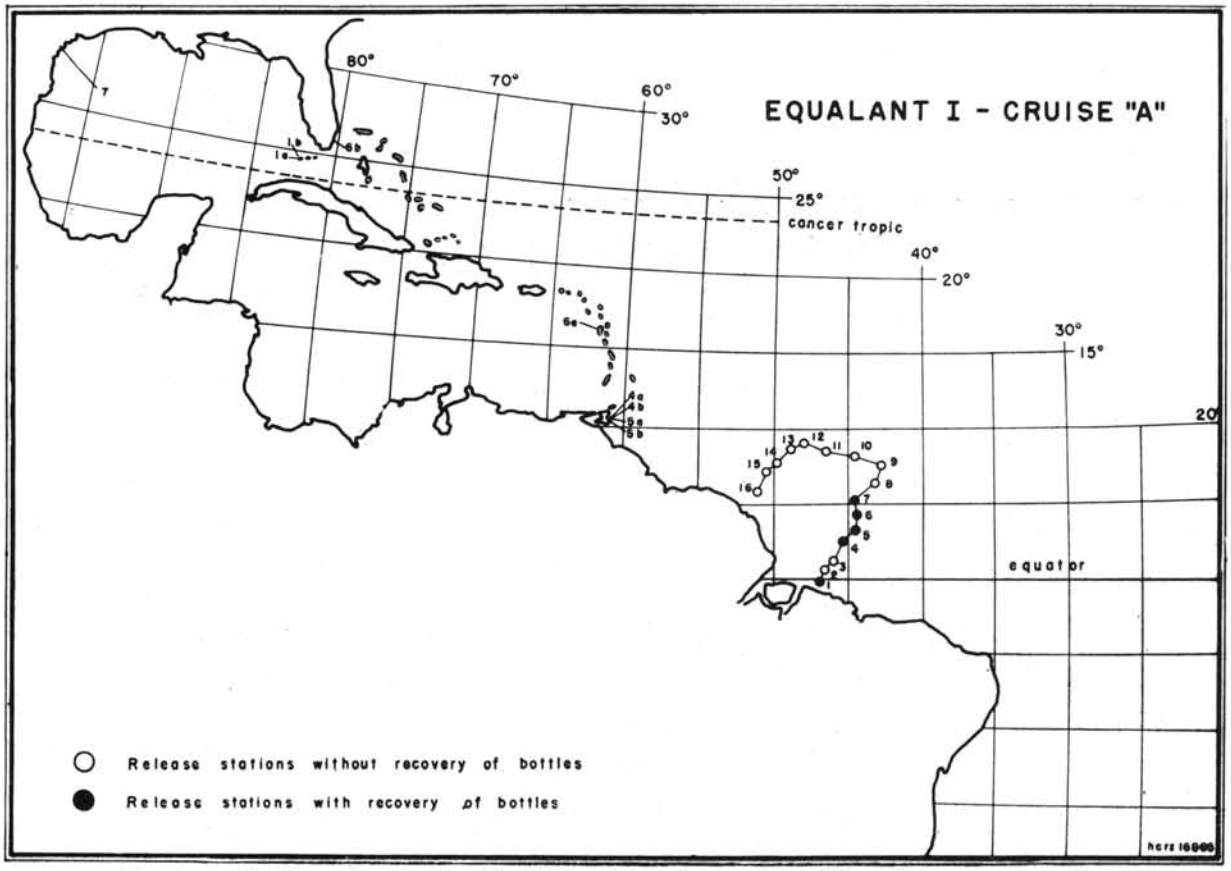

Fig. 1 — Position of stations with drift bottle releases — 1963 — February 19 to 26. The locality of recovered bottles shows numbers of respective release stations.

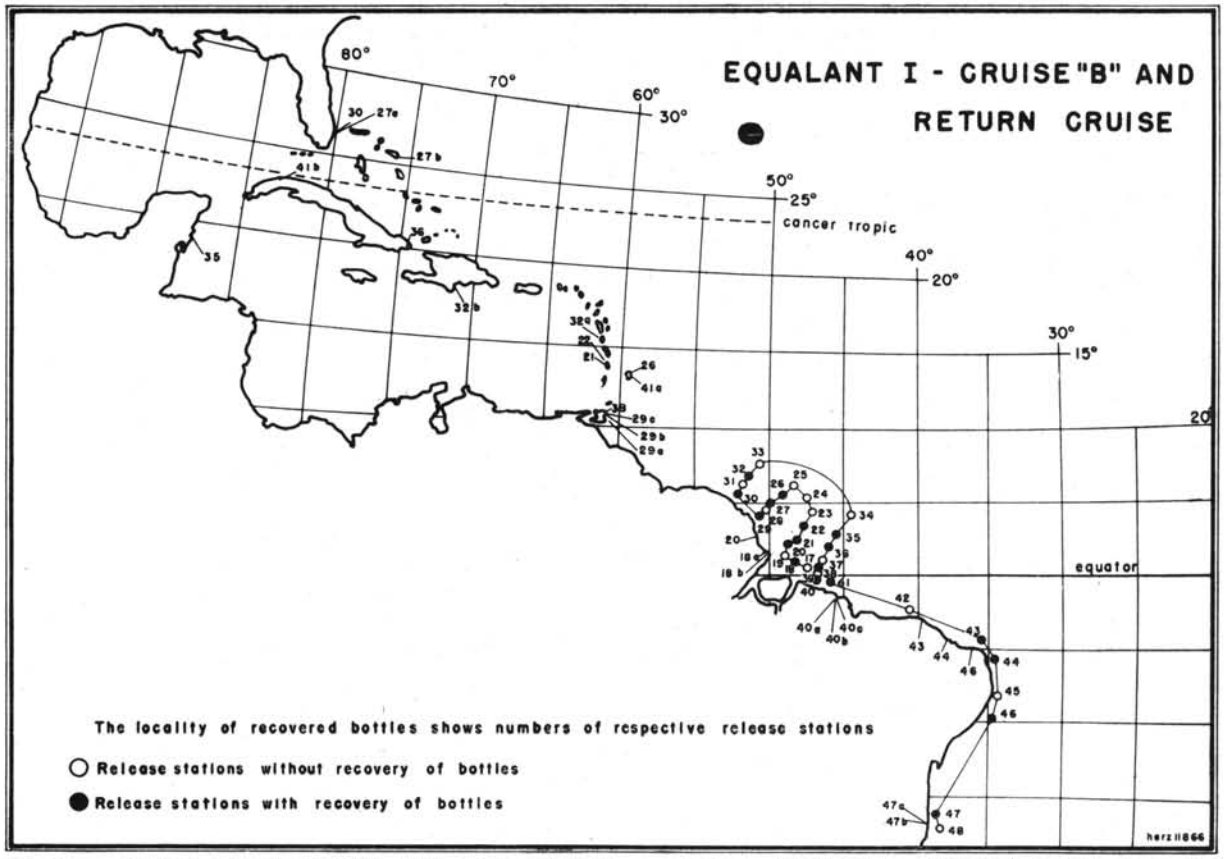

Fig. 2 — Position of stations with drift bottle releases — 1963 — March 17 to 26 and March 26 to April 4. The locality of recovered bottles shows numbers of respective release stations.

tor up to the Guiana-Brazilian coast. Between these trade wind regions there usually is a zone of variable width, the so called equatorial calms or the doldrum belt (YZAL, 1960; RODEN, 1962).

Furthermore in March the southeast trades cross the Equator and invade the northeastern and northern area off the coast of Brazil up to the Guiana-Brazilian coast (*op. cit.*).

According to PARR (1937), the stress exerted on the surface waters between the Lesser Antilles and the Yucatan Channel by the prevailing easterly winds produces a piling up of waters in front of this narrow channel. According to DIETRICH & KALLE (1957), the Florida Current is mainly a direct continuation of the current through the Yucatan Channel. Since the waters of the Gulf of Mexico form independent eddies only a small fraction enters the Florida Current (DIETRICH, 1939; DIETRICH & KALLE, 1957). Numerous eddies are present also on the flanks of the main current of the Caribbean Sea, f. inst. between Nicaragua and Colombia and between Jamaica and Cuba (SVERDRUP *et al.*, 1955).

Such are, in accordance with that literature, the conditions of the area studied which may give an idea of the numerous influences to which drift bottles are exposed, mainly on their longer routes; in addition to these they are exposed to accidental factors, such as storms, tropical cyclones, waves and so on.

RESULTS

The stations of cruise A (1-16) and B (17-40) from which bottles were recovered, are located within an area of about 300 nm off the northern Brazilian coast (Fig. 1 and 2). Out of the 396 bottles released, 28, or 7%, were recovered. No bottles released in February from stations between 05°N and 09°N (Fig. 1) were recovered; however, a few recoveries were obtained from bottles released there in March (Fig. 2). All bottles recovered, except those from station 40 (Fig. 2), drifted in northwestern or north-northwestern direction. Out of the 80 bottles released after cruise B "Return Cruise" (stat. 41-48), seven, or 8,7%, were recovered. They followed the same direction as mentioned above except for two bottles, released at 16°S and 038°W (stat. 47) which reached the State of Bahia, Brazil.

The recovered bottles are classed in five groups, according to the area of recovery and to their differant ranges of velocity (Tab. I-V; Fig. 3-5).

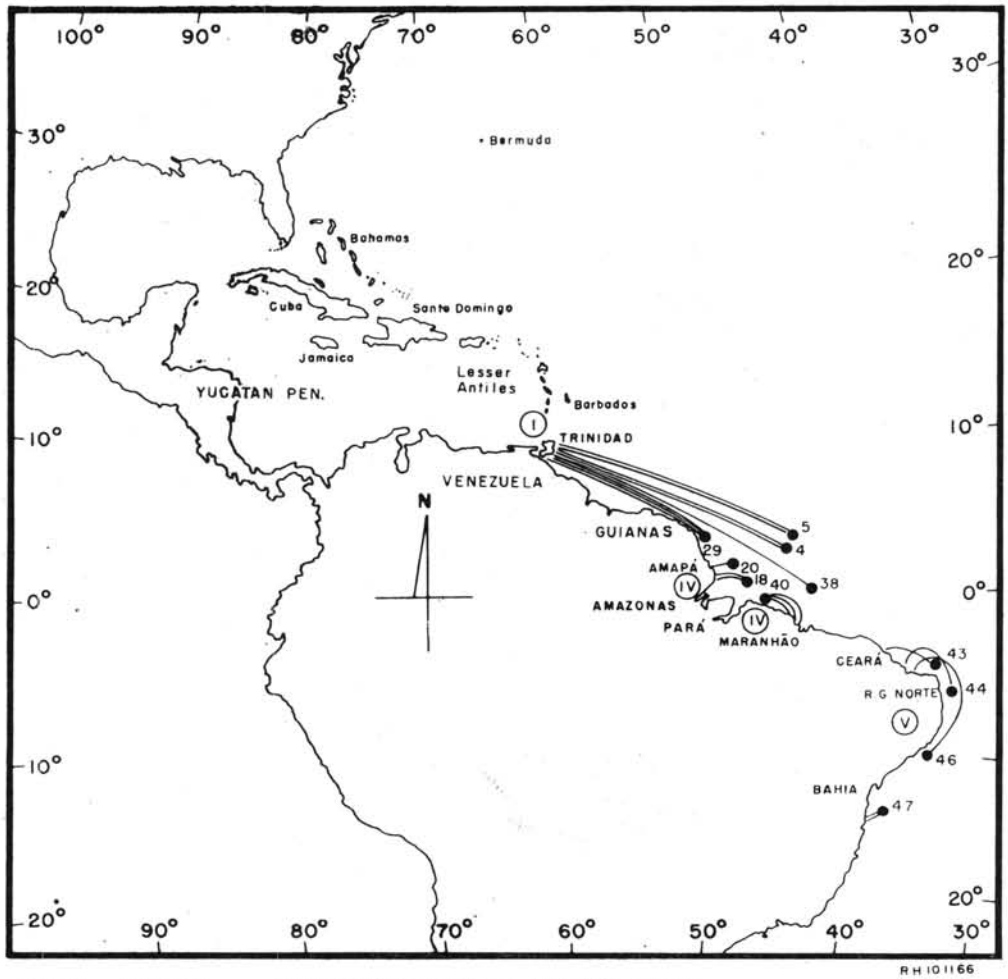

Fig. 3 — Group I — Drift bottles found at Trinidad Island.
— Group IV — Drift bottles found at the north coast of Brazil.
— Group V — Drift bottles found at the northeast coast of Brazil.

GROUP I: Isle of Trinidad — The bottles recovered showed velocity ranges from 20,8 to 87,16 nm/24 hr, with a mean value of 52,0 nm per day or 2,2 knots (Tab. I; Fig. 3).

TABLE I — *Group I — Bottles found at Trinidad Island*

Conv. Stat. n.º	Locality where found	Probable days at sea	Distance nm	Velocity nm/24h	Velocity knots	Observations
4	Trinidad Island-BWI	12	1020	85,00	3,54	Highest velocity:
5	Trinidad Island-BWI	12	1046	87,16	3,60	87,16 nm/24h
	Trinidad Island-BWI	12	1046	87,16	3,60	3,60 knots
29	Trinidad Island-BWI	24	720	30,05	1,25	
	Trinidad Island-BWI	26	720	27,69	1,15	
	Trinidad Island-BWI	28	720	25,72	1,07	
38	Trinidad Island-BWI	50	1046	20,80	0,87	
Mean velocity:				52,0	2,2	

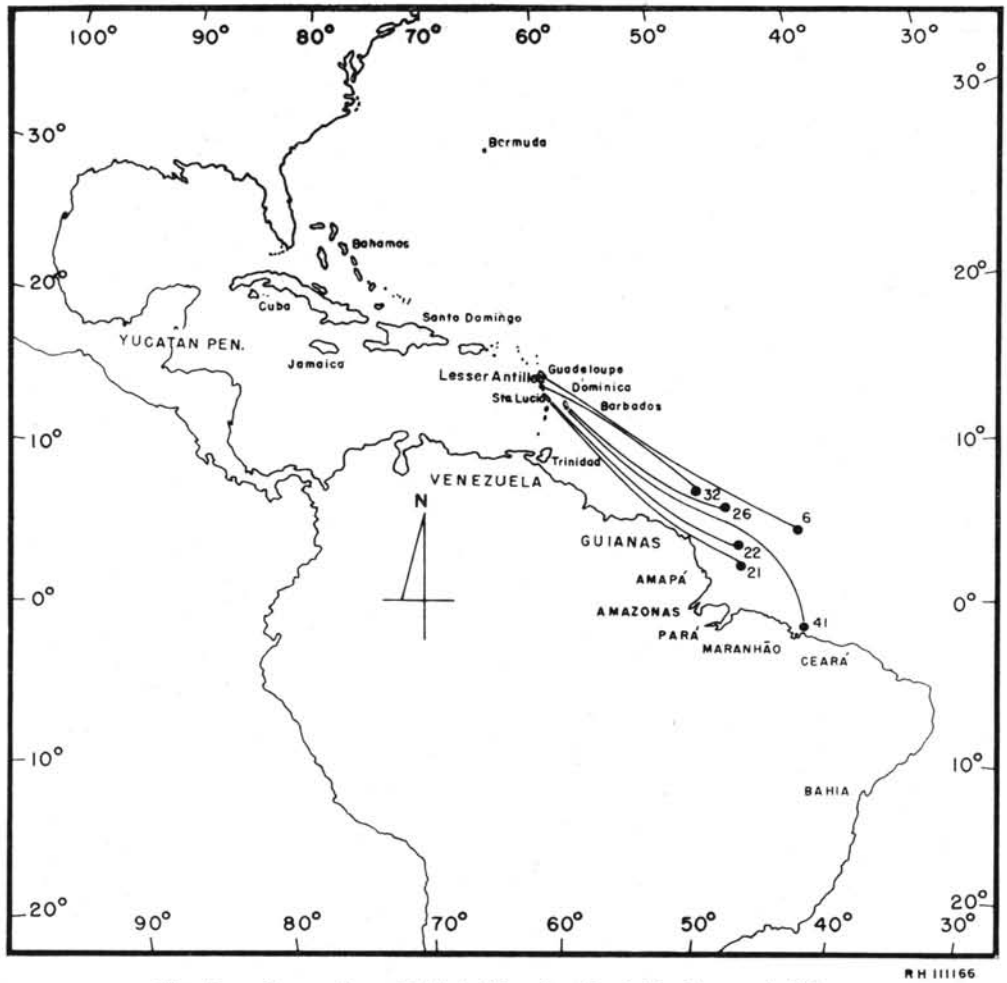

Fig. 4 — Group II — Drift bottles found at the Lesser Antilles.

GROUP II: Lesser Antilles — The velocity of the recovered bottles ranged from 10,3 nm/24 h to 25,7 nm/24 h. The mean value wos about 17,55 nm/24 h or 0,73 knots (Tab. II; Fig. 4).

GROUP III: This group includes bottles which apparently have followed the Caribbean and Florida Currents with velocities ranging from 4,14 nm/24 h to 20,0 nm/24 h with a mean value of 10,8 nm per day or 0,44 knots (Tab. III). Fifty five percent of these bottles drifted to the Florida area, while others were recovered in different places of the Caribbean Sea (Tab. III; Fig. 5).

TABLE II — *Group II — Bottles found at the Lesser Antilles*

Conv. Stat. n.º	Locality where found	Probable days at sea	Distance nm	Velocity nm/24h	Velocity knots	Observations
6	Guadeloupe-FWI.	100	1220	12,20	0,51	Highest velocity:
21	Sta. Lucia-BWI.	43	995	23,13	0,96	25.65 nm/24h
22	Sta. Lucia-BWI.	38	975	25,65	1,07	1,07 knots
26	Barbados-BWI.	32	755	23,59	0,98	
41	Barbados-BWI.	123	1290	10,48	0,44	
32	Dominica-BWI.	77	790	10,26	0,43	
Mean velocity:				17,55	0,73	

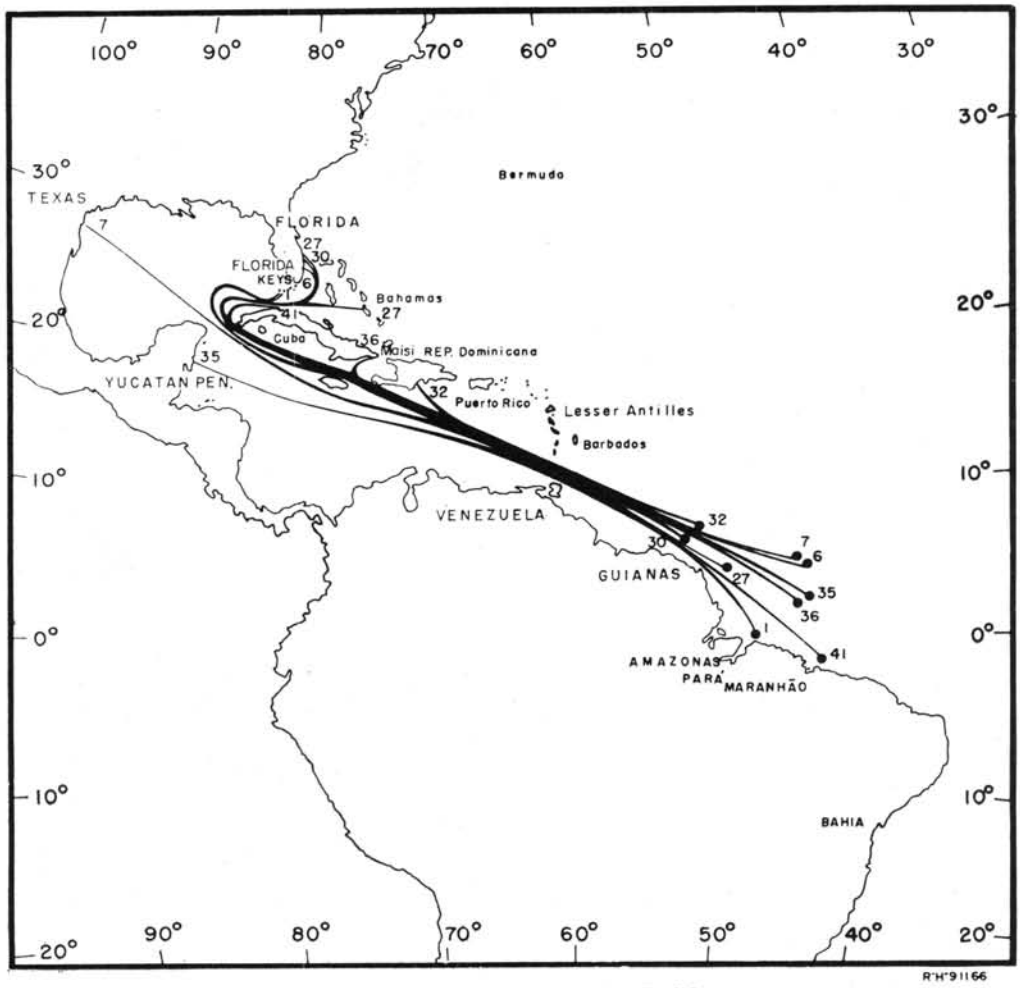

Fig. 5 — Group III — Drift bottles found at the Caribbean and Florida area.

TABLE III — *Group III — Bottles found within the Caribbean and Florida area*

Conv. Stat. n.º	Locality where found	Probable days at sea	Distance nm	Velocity nm/24h	Velocity knots	Observations
1	Florida Keys-USA	187	2890	15,45	0,64	Highest velocity:
	Florida Keys-USA	347	2890	8,32	0,35	19,88 nm/24h
6	Florida-Homestead-USA	402	3070	7,63	0,31	0,83 knots
30	Florida-Miami-USA	197	2480	12,58	0,52	
27	Florida-Miami-USA	133	2645	19,88	0,83	
	Bahama Isl.-BWI	408	2800	6,82	0,28	
7	Texas-Corp. Chris.-USA	786	3260	4,14	0,17	
35	México-Xcalak	287	2650	9,23	0,38	
41	Cuba-Habana	252	2920	11,58	0,48	
36	Cuba-Maisi	175	2100	12,00	0,50	
32	S. Domingos-Rep. Dominicana	127	1350	10,62	0,44	
Mean velocity:				10,75	0,44	

TABLE IV — *Group IV — Bottles found at the northern coast of Brazil*

Conv. Stat. n.º	Locality where found	Probable days at sea	Distance nm	Velocity nm/24h	Velocity knots	Observations
40	Maranhão-Brazil	10	100	10,00	0,42	Highest velocity:
	Maranhão-Brazil	28	100	3,60	0,15	(Maranhão):
	Maranhão-Brazil	151	100	0,66	0,03	10,00 nm/24h 0,42 knots
18	Amapá-Brazil	39	210	5,38	0,22	Highest velocity:
	Amapá-Brazil	49	210	4,28	0,18	(Amapá):
20	Amapá-Brazil	422	125	0,29	0,01	5,38 nm/24h 0,22 knots
Mean velocity (Maranhão):				4,75	0,20	
Mean velocity (Amapá):				3,32	0,14	

TABLE V — *Group V — Bottles found at the northeastern coast of Brazil*

Conv. Stat. n.º	Locality where found	Probable days at sea	Distance nm	Velocity nm/24h	Velocity knots	Observations
43	Ceará-Brazil	21	260	7,60	0,32	Highest velocity:
44	Ceará-Brazil	20	220	11,00	0,46	11,00 nm/24h
46	Rio Grande do Norte-Brazil	46	380	8,20	0,34	0,46 knots
Mean velocity:				8,93	0,37	

GROUP IV: Northern Brazil — Bottles released in front of the mouth of Pará and Amazonas rivers were recovered at Maranhão and Amapá. The bottles that drifted to Maranhão, from station 40, showed a velocity range from 0,66 nm/24 h (151 days at sea!) to 10,0 nm/ 24 h. The velocities of the bottles found at Amapá, released at stations 18 and 20, showed the lowest values of all, ranging from 0,29 nm/24 h (422 days at sea!) to 5,4 nm/ 24 h (Tab. IV; Fig. 3).

GROUP V: Northeastern Brazil — The bottles were released during the return cruise off the northeastern and eastern coasts of Brazil. The velocity range of this group is from 7,6 nm per day to 11,0 nm per day, with a mean value of about 9,0 nm per day or 0,4 knots (Tab. V; Fig. 3).

TABLE VI a — *CRUISE A*

RELEASE					RECOVERY				
Station		Date	Position		Locality	Position		Date	Probable
Cruise Number	Convent. Number	1963 M - D*	Latitude o ,	Longitude o ,W	where found	Latitude o ,	Longitude o , W	M-D-Y*	days at sea
A- 2	1	02/20	00 02.0 S	047 02.0	Florida Keys-USA	25 17 N	081 00	08/26/63	187
					Florida Keys-USA	25 17 N	081 00	02/02/64	347
A- 3	2	02/20	00 32.0 N	046 43.2	—	—	—	—	—
A- 4	3	02/20	01 04.4 N	046 29.6	—	—	—	—	—
A- 6	4	02/20	02 55.4 N	045 14.3	Trinidad-BWI	10 08 N	061 00	03/05/63	12
					Trinidad-BWI	10 08 N	061 00	03/ ? /63	?
A- 7	5	02/21	03 34.2 N	044 44.3	Trinidad-BWI	10 08 N	061 00	03/05/63	12
					Trinidad-BWI	10 08 N	061 00	03/05/63	12
A- 8	6	02/22	04 51.0 N	044 29.0	Guadeloupe, FWI	15 53 N	061 13	06/02/63	100
					Florida-USA	25 45 N	080 15	03/31/64	403
A- 9	7	02/22	05 06.8 N	044 51.6	Texas-USA	27 47 N	097 26	04/18/65	786
A-10	8	02/23	06 31.0 N	043 14.6	—	—	—	—	—
A-11	9	02/23	07 38.5 N	042 30.5	—	—	—	—	—
A-12	10	02/24	08 04.0 N	044 39.0	—	—	—	—	—
A-13	11	02/24	08 43.8 N	046 34.3	—	—	—	—	—
A-14	12	02/24	09 33.1 N	048 16.2	—	—	—	—	—
A-15	13	02/25	08 52.3 N	049 01.8	—	—	—	—	—
A-16	14	02/25	08 02.2 N	049 51.1	—	—	—	—	—
A-17	15	02/25	07 30.0 N	050 30.4	—	—	—	—	—
A-18	16	02/26	05 52.8 N	051 02.6	—	—	—	—	—

* M = Month; D = Day; Y = Year.

DISCUSSION

The fact that no recovery was obtained from the bottles released at 9 stations (8 — 16) from cruise A, within the area of about 05°N — 09°N and from about 043°W — 051°W, seems to confirm the presence of an eastward component of the surface current (NEUMANN, 1960; 1965; COCHRANE, 1963).

On the other hand, the recovery of 9 bottles (18%) out of those launched, at the same time, at 5 stations situated in the area about the Equator up to 05°N and 043°W to 047°W (Fig. 1) confirm, with their results, the existence of a strong current along the north coast of Brazil within a zone of 300 nm in the northwestern direction (Guiana Current).

During cruise B, one month later, 7 stations were located in approximately the same area about 05°N up to 08°N and from about 045°W to 052°W (stat. 24-26; 30-33). From these only 4 bottles (5,7%) were recovered. However, from 17 stations located between the Equator and 05°N and from about 045° to 052°W (stat. 17-23; 27-29; 34-40) 16 bottles (9,4%) were recovered (Fig. 2). This suggests that the eastward component of the surface current may have been more developed in February than in March in the first area mentioned, while later on drift currents produced by the trades might have been the dominant ones (NEUMANN 1960, p. 334).

The first bottles returned from Trinidad Island showed the highest speeds (Tab. I). The very high velocity of more than 85 nm per day or 3,5 knots (3 bottles out of 7 recoveries) may be explained by the information received that the days before the recovery, early March 1963, had been stormy. Compare, for example, the velocity of 2,8 knots found by KEEN & CHIMIAK (1955) in the Caribbean sea.

The bottles recovered at the Lesser Antilles proved that the strong current observed off the north Brazilian coast reached that area. The greatest velocity in the Lesser Antilles area is that developed by the bottle which stranded at St. Lucia Island with about 26 nm per day or 1,1 knots in April 1963 (Tab. II).

KEEN & CHIMIAK (1955) showed the presence of a northeastern surface current through the Windward Passage, which explains the recovery of a bottle at Maisi, Cuba. (Fig. 5; Table III).

Out of the group of bottles which reached the Florida area (Tab. III; Fig. 5), the fastest was one that ran from the north coast of Brazil to Miami (± 2650 nm) in 133 days, with an average speed of 20 nm per day or 0,83 knots. However, the longest route seems to have been that of a bottle, laun-

TABLE VI b — *CRUISE B*

RELEASE					RECOVERY				
Station		Date	Position		Locality	Position		Date	Probable
Cruise Number	Convent. Number	1963 M-D *	Latitude o ,	Longitude o , W	where found	Latitude o ,	Longitude o , W	M-D-Y*	days at sea
B- 1	17	03/17	00 45.7 N	047 08.9					
B- 2	18	03/17	01 17.0 N	048 01.0	Amapá-Brazil	01 15 N	050 00	04/25/63	039
					Amapá-Brazil	01 15 N	050 00	05/05/63	049
B- 3	19	03/17	01 47.0 N	048 55.5					
B- 4	20	03/17	02 11.3 N	048 35.5	Amapá-Brazil	02 32 N	050 45	05/12/64	422
B- 5	21	03/17	02 35.7 N	048 17.9	Sta. Lucia-BWI	13 50 N	060 55	04/29/63	043
B- 6	22	03/18	03 30.0 N	047 53.5	Sta. Lucia-BWI	14 01 N	060 59	04/25/63	038
B- 7	23	03/18	04 22.5 N	047 00.0					
B- 8	24	03/18	05 15.2 N	047 34.0					
B- 9	25	03/19	06 03.0 N	048 13.3					
B-10	26	03/19	05 26.8 N	049 04.1	Barbados-WI	13 04 N	059 30	04/20/63	032
B-11	27	03/19	04 41.7 N	049 52.5	Florida-USA	25 45 N	080 15	07/30/63	133
					Bahama Isl.-BWI	24 12 N	076 26	05/01/64	408
B-12	28	03/19	04 26.1 N	050 11.2					
B-13	29	03/19	04 08.0 N	050 31.0	Trinidad-BWI	10 17 N	061 00	04/12/63	024
					Trinidad-BWI	10 08 N	061 00	04/14/63	026
					Trinidad-BWI	10 08 N	061 00	04/16/63	028
B-14	30	03/20	05 45.5 N	052 07.1	Florida-USA	26 41 N	080 02	10/03/63	197
B-15	31	03/20	06 18.0 N	051 41.5					
B-16	32	03/20	06 54.2 N	051 18.2	Dominica-WI	15 18 N	061 23	06/05/63	077
					S. Domingos-R. Dom.	18 30 N	069 57	07/25/63	127
B-17	33	03/21	07 31.0 N	050 12.5					
B-18	34	03/22	04 06.3 N	044 44.0					
B-19	35	03/22	03 02.0 N	045 21.0	Xcalak-Mexico	18 17 N	087 50	01/03/64	287
B-20	36	03/22	02 06.0 N	045 50.4	Maisi-Cuba	20 16 N	074 09	09/13/63	175
B-21	37	03/23	01 05.0 N	046 23.8					
B-22	38	03/23	00 39.8 N	046 38.0	Trinidad-BWI	10 08 N	061 02	05/12/63	050
B-23	39	03/23	00 03.0 N	046 59.0					
B-24	40	03/23	00 17.3 S	047 10.6	Maranhão-Brazil	01 25 S	045 35	04/02/63	010
					Maranhão-Brazil	01 40 S	045 12	04/20/63	028
					Maranhão-Brazil	01 40 S	045 45	08/21/63	151

* M = Month; D = Day; Y = Year.

ched at station 7, which reached Texas (Corpus Christi) in the Gulf of Mexico (3260 nm) in 786 days. (Fig. 5). The cause of the long time spent at sea may be the large eddies which are formed in the Gulf of Mexico, a common feature of this area (DIETRICH, 1939); also that it had been released in the area where the eastward component seems to predominate at the time of release.

The bottles which performed the longest routes might have been exposed to the effect of different factors such as wind, waves, eddies etc. Therefore it is difficult to have an idea of the real velocity of the current. Two bottles, f. example, of the same station 1 reached the same locality, Florida Keys (Fig. 5); one after 187 days with an average velocity of 15,5 nm per day or 0,64 knots and the other after 347 days with a mean velocity of only 8,3 nm per day or 0,35 knots. KARWOSKI (1963) refers that drift bottles are moved by waves in different directions. However the fact mentioned above suggests that although influenced by waves, the force of the main current predominates. It is possible that the second bottle drifted around the Gulf of Mexico before stranding at the Florida Keys.

Referring to group IV, which comprises the shortest routes and the lowest velocity values of all bottles, it seems to represent coastal currents. The bottles which drifted to Maranhão were the only ones which drifted southeastward along the coast; they had been released at the same station and were stranded at the same locality at different dates which seems to indicate the presence of a coastal current

TABLE VI c — *RETURN CRUISE*

RELEASE					RECOVERY				
Station		Date	Position		Locality	Position		Date	Probable
Cruise Number	Convent. Number	1963 M - D*	Latitude ° , S	Longitude ° , W	where found	Latitude ° ,	Longitude ° ,	M-D-Y*	days at sea
1	41	03/27	01 48.7	043 42.4	Barbados-WI	13 13 N	059 30	07/28/63	123
					Habana-Cuba	23 07 N	082 25	12/04/63	252
2	42	03/28	02 36.0	040 34.5	—	—	—	—	—
3	43	03/29	04 47.0	035 29.0	Ceará-Brazil	03 54 S	038 12	04/19/63	021
4	44	03/29	05 36.0	034 55.0	Ceará-Brazil	04 16 S	037 43	04/18/63	020
5	45	03/30	08 26.0	034 38.0	—	—	—	—	—
6	46	03/30	10 04.0	035 14.0	R. G. Norte-Brazil	04 57 S	036 53	05/15/63	046
7	47	04/02	16 44.5	038 31.0	Bahia-Brazil	17 55 S	039 22	05/15/63	043
					Bahia-Brazil	17 55 S	039 22	05/15/63	043
8	48	04/02	17 53.5	038 27.0	—	—	—	—	—

* M = Month; D = Day; Y = Year.

in that direction (Fig. 3). The higher velocities of the bottles of the northeastern Brazil group seems to confirm the presence of the stronger South-Equatorial Current (Fig. 3).

No recoveries were reported from the northern coast of South America and the eastern coast of Central America, from Trinidad Island up to the southeastern Yucatan, Mexico. This indicates that the current is strongest on the northeastern side of the Caribbean Sea which is in a good agreement with the action of Corioli's force. But we remember the small material and the small density of the human population on the mentioned coast (Fig. 3-5).

CONCLUDING REMARKS

1 — The recoveries of drift bottles from stations located as far as 300 nm off the northern coast of Brazil confirm the presence of a strong current in a north-western direction. This current as well as that present along the eastern coast of Brazil, also confirmed by the bottle released off the coast of Maceió (10°04'S — 035°14'W) and recovered on the northeast coast (Tab. V), are believed to represent branches of the South Equatorial Current.

2 — The bottles released about 140 nm in front of the mouth of Amazonas river suggest a slow drift current along the coast of Amapá. Those released near the mouth of the Pará river, are the only ones which drifted southeastward along the coast, they suggest a somewhat faster coastal current to Maranhão (Fig. 3).

3 — Several recoveries of bottles at Trinidad Island showed clearly the effect of the strong Guiana Current: its mean velocity in March and April was about 2,2 knots as evaluated by the travel velocity of the bottles. Very strong winds (storm) in the first days of March may be responsible for an apparent increase of velocity, to an estimated 3,6 knots.

4 — The recoveries at Lesser Antilles confirm the penetration of the South Equatorial Current through that area into the Caribbean Sea. The greater part of the bottles and the fastest reached the area in April. One of them drifted with a velocity of 25,6 nm per day or 1,1 knots.

5 — After having drifted a probable route of more than 2600 nm one bottle reached Miami with an average speed of 20 nm per day or 0,83 knots. The mean velocity value for all bottles concerning the Caribbean and Florida area was 10,8 nm per day or 0,4 knots.

6 — The region off the northern coast of Brazil, between about 05°N and 09°N and extending to the West up to 050°W, seems to have been during late February under the influence of an eastward component of the surface current; this fact would in part explain the complete lack of recovery of bottles out of 90 which were launched within this area. This influence seems to have been weaker during cruise B in late March. The bottle which was found after more than two years (786 days) in Texas had been released late February at a station just within the limits of the area mentioned above (stat. 7: 05°06'N-044°51'W).

7 — The recoveries of bottles show that the current seems to be stronger on the northeastern side of the Caribbean Sea.

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SUMÁRIO

Em fevereiro-março de 1963 foram lançadas 476 garrafas de deriva diante das costas norte e nordeste do Brasil durante a Operação Equalant para o programa ICITA; destas foram recuperadas até agora 35.

Estas foram classificadas em cinco grupos conforme a sua área de encontro e segundo as variações de velocidade do percurso.

GRUPO I — Ilha de Trinidad — As garrafas recuperadas apresentavam variações de velocidade entre 20,8 a 87,16 mn/24 h com um valor médio de 52,0 mn por dia ou 2,2 nós (Tab. I).

GRUPO II — As pequenas Antilhas — A velocidade das garrafas recuperadas variaram de 10,3 mn por dia a 25 mn por dia. O valor médio esteve ao redor de 17,55 mn por dia ou 0,73 nós (Tab. II).

GRUPO III — Mar dos Caraibas e Florida — Êste grupo compreende garrafas que aparentemente acompanharam as Correntes das Caraíbas e da Flórida com velocidades que variaram de 4,14 mn por dia a 20 mn por dia com uma velocidade média de 10,8 mn por dia ou 0,44 nós (Tab. III). Cêrca de 50% dessas garrafas convergiram para a área da Flórida enquanto que outras foram encontradas em diferentes locais do Mar dos Caraíbas (Tab. III).

GRUPO IV — Norte do Brasil — Compreende as garrafas lançadas diante das desembocaduras dos rios Pará e Amazonas. As garrafas que chegaram ao Maranhão, da estação 40, apresentaram uma velocidade entre 0,66 mn por dia (151 dias no mar) e 10,0 mn por dia e foram as únicas que derivaram em direção sudeste. As velocidades das garrafas encontradas no Amapá, lançadas nas estações 18 e 20, representam os valores mais baixos de todos, variando entre 0,29 mn por dia a 4,4 mn por dia (Tab. IV).

GRUPO V — Nordeste do Brasil — As garrafas foram lançadas durante o cruzeiro de retôrno diante das costas do nordeste do Brasil. A variação de velocidade dêste grupo vai de 7,6 mn por dia para 11,0 mn por dia, com um valor médio de 9,0 mn por dia ou 0,4 nós (Tab. V).

Com exceção das garrafas da estação 40 que derivaram em direção sudeste, tôdas as outras foram encontradas a noroeste do seu local de lançamento.

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