
From AFIO's THE INTELLIGENCER
JOURNAL OF U.S. INTELLIGENCE STUDIES
VOLUME 26 • NUMBER 2 • Winter-Spring 2021 $15 SINGLE COPY PRICE

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When Intelligence Made a Difference

— WWII —

The Breaking of JN-25 and its Impact in the War Against Japan

by Peter C. Oleson

Introduction

While US Navy radio intelligence efforts in the 1930s and 1940 and 1941 had been focused on Japan, there was no specific forewarning of the surprise attack on Pearl Harbor. The decryption of the Japanese diplomatic PURPLE codes by the US Army's Signal Intelligence Service (SIS) clearly showed a deteriorating relationship with an aggressive Japan, especially after the freezing of Japanese assets by the US in July 1941.[1]

Navy cryptanalytical resources were very limited.[2] Priority went to the high-level diplomatic cables (i.e., PURPLE). Station Hypo, "... the radio intelligence unit at Pearl Harbor [was assigned] to work exclusively on the Imperial Navy's Admirals' Code rather than have any role in deciphering diplomatic codes or the more widely used JN-25," the Imperial Japanese Navy's (IJN) command and control code.[3] Station C ("Cast"), the radio intelligence unit in the Philippines, and the Navy Department's OP-20-G in Washington led the cryptanalytical attack on JN-25b, introduced in December 1940.[4] Before December 7, 1941 Navy cryptanalysts could not read any of the JN-25 messages. "The net result was that we detected absolutely no warning of the impending attack on Pearl Harbor."[5] Imperial Japanese Navy (IJN) communications security and misinterpreted radar indications on the morning of December 7 contributed to the lack of warning.[6] Ironically, IJN messages intercepted prior to Pearl Harbor but not decoded until after the war strongly hinted at planned operations against Hawaii.[7]

JN-25 – the Imperial Japanese Navy's Command and Control Code

The IJN introduced two new enciphered codes for general purposes in 1939; American cryptanalysts dubbed one of the systems the "Flag Officers Code" and the other, JN-25. The US Navy got little intercept in the Flag Officers Code and the effort against it was abandoned in December 1941.[8]

As historian John Prados explains, to communicate over radio the alphabet is reduced to a code, such as the dots and dashes of Morse Code. To protect easily read plaintext the sender uses a letter or digital transposition or substitutes whole words or phrases that only the sender and receiver know. Numeric messages could have a random additive number, which then "were considered 'enciphered' or 'encrypted.'" A cryptanalyst's recovery of a message required getting rid of the additives ("deciphering") using mathematical techniques, which were aided by having multiple intercepted messages allowing comparison of commonalities to gain entry into the code.[9]

"JN-25 consisted of a codebook with approximately 27,500 entries and an additive book for superenciphering the codebook values. The additive book consisted of 300 pages, each page containing 100 random five-digit groups. It should be noted that this additive book for JN-25 was not a one-time pad: the five-digit groups were re-used, as needed. In studying JN-25, US cryptanalysts had to collate large numbers of Japanese messages over time. Their first goal was to recover the indicator in each message which showed where in the additive book numbers were taken; then recover and strip away the additives themselves to get

1. The US Navy devised an analogue machine to "strip the ciphers" off of the Japanese Foreign Ministry's Red code in the 1930s. After the Japanese changed to the more complex PURPLE code in 1939 it too was solved by September 1940, and the US developed an analogue machine to decipher up to seventy-five messages per day. (John Prados. *Combined Fleet Decoded: The Secret History of American Intelligence and the Japanese Navy in World War II*. Annapolis, MD: Naval Institute Press, 1995, p 163.)
2. Army SIS assets were also limited in Washington. SIS and Op-20-G shared the translation workload for PURPLE decrypts.
3. Prados, p 166.
4. Prados, p 175.
5. Capt. Biard, "Joining the Dungeon," *https://stationhypo.com*. See also Stephen Budiansky. "The monthly reports filed by OP-20-G confirm that at the time of the Pearl Harbor attack, not a single JN-25 message from the previous 12 months had been read." "Too Late for Pearl Harbor." *U.S. Naval Institute Proceedings 125*, no. 12 (Dec. 1999): p 47-51.
6. For the story about the missed indications from radar see Harry A. Butowsky, PhD, "Mystery of the Opana Radar Site," *http://npshistory.com/publications/valr/opana-radar-site.pdf*.
7. Prados, p 156-7.
8. "JN-25," *https://www.nsa.gov/about/cryptologic-heritage/center-cryptologic-history/pearl-harbor-review/jn25/*.
9. Prados, p 74.

down to the codebook values; and, finally, recover the meanings in plaintext Japanese of the underlying codebook values, which would allow messages to be read, at least in part. A second version of this system, known to US Navy cryptanalysts as JN-25b, was introduced on December 1, 1940. Six months later, the Japanese Navy replaced the additive book. The additive book was replaced in August and again on 4 December 1941, three days before the Japanese attack on American bases in Hawaii. These rapid changes in the codebook and its additive required that US cryptanalysts begin again with each change — virtually at the beginning — to attack the system. It is estimated that prior to the change of the additive book in August 1941, the cryptanalysts had recovered only 2,000 code groups in JN-25 — about 4% of the codebook — and these were mostly numerals and stereotyped phrases."[10]

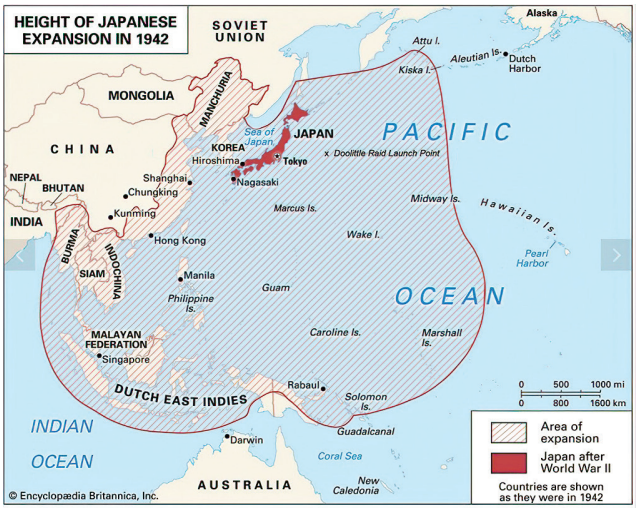
US Navy cryptanalytic efforts were complicated by the scarcity of cryptanalysts and Japanese translators. The IJN prior to and during World War II developed a form of Morse code which used a syllabary of seventy-three kana, each with one or two suffixes that might alter its meaning."[11] As explained by two Australian professors of mathematics and statistics,

> *"The methods used in the code breaking behind the successes of Allied Pacific Signals Intelligence are quite different to those used against encryption machine ciphers such as the [Nazi's] Enigma.*
>
> *The reason is that the main cipher systems used by both the... IJA and the... IJN were based on code books rather than a machine."*[12]

Much of insight gained from radio intelligence before the decryption of JN-25 came from the externals of a transmitted message. Each radio intercept station could get a bearing of a transmission. By comparing two or more station's bearings allowed calculation of a transmitter's geographic position. If bearings changed the transmitter was from a ship or aircraft and its direction and speed could be calculated. As many messages were transmitted at high frequencies, the US Navy developed by 1940 a network of sixteen High-Frequency Direction Finding (HFDF – "huff-duff") stations covering the Atlantic and Pacific Oceans.[13]

Attacking JN-25

On December 10, 1941 the Navy Department gave Hypo permission to attack the Japanese "five-digit, two-part, enciphered, widely used strategic code," JN-25.[14] In early 1942, Commander Joseph Rochefort, the commander of Station Hypo, and his staff began to make progress, but painfully slowly.[15] In early January 1942 the initial breaks were made by Station Cast, OP-20-G in Washington, and soon thereafter by the British Far Eastern Combined Bureau (FECB), an outpost of Britain's Government Code and Cipher School at Bletchley Park. "By the end of January... we were obtaining significant bits of information in more and more messages." By February "... bits of operational intelligence we did... succeed in pulling out of JN-25 sometimes were verifiable, as in the case when we could put a submarine on the track of the carrier *Kaga*, which was returning to Japan for repairs after hitting a shoal off Malay."[16]



By March, the US had cracked part of JN-25. However, it could intercept only about 60 percent of transmissions and by May had the resources to analyze only about 40 percent of intercepted messages. Even then, code breakers typically could read only 10 to 15 percent of the code groups in a message. Navy radio intelligence traffic analysts primarily used direction-finding and message externals to learn about order of battle and disposition of forces and where ships were heading.[17]

10. "JN-25," NSA.
11. Prados, p 9. "Katakana and hiragana are both syllabic forms of writing developed in the ninth century to simplify written Japanese...."
12. Peter Donovan & John Mack. *Code Breaking in the Pacific*. Switzerland: Springer International Publishing, 2014. Preface.
13. Prados, p 75.
14. Biard. "Joining the Dungeon."
15. *https://stationhypo.com/2020/03/05/march-5-1942-station-hypo-started-reading-japanese-jn-25-2/#more-11789*.
16. CAPT Biard. "Doolittle Raid and the Battle of Coral Sea," *https://stationhypo.com/2016/12/26/capt-biard-doolittle-raid-and-the-battle-of-coral-sea-part-3-of-4/#more-3057*.
17. "Battle of Coral Sea – What was the 'RZP' Campaign?" *https://stationhypo.com/2017/04/17/part-1-of-5-battle-of-coral-sea-what-was-the*

A notable cryptanalytic breakthrough occurred as early as January 18, 1942. Enough of the code groups in three intercepts allowed for partial translation that Rochefort, a Japanese linguist, translated as "koryaku butai," – "assault landing force." Preceding the code group was the letter "R." Rochefort believed, and Nimitz' intelligence officer, Commander Edwin Layton agreed, that the "R' was Rabaul. Rochefort deduced that the "assault landing force" was going to head south from Truk and attack Rabaul on the island of New Britain.[18] Nimitz saw an opportunity with the IJN committed south and in February and March 1942 launched carrier air raids from the USS *Enterprise* and USS *Yorktown* on the Marshall Islands, Wake, and Marcus Island. The surprise raid on Marcus Island alarmed the Japanese, being only 1,148 miles from Tokyo, and led to an increase in radio traffic that was beneficial for Allied codebreakers.[19]

Battle of the Coral Sea (April-May 1942)

Intercepts by Stations Cast and Hypo on March 25 and April 8 referenced an "RZP campaign," which no one had heard of. It was known that the Japanese used geographic designations that started with "R" for Australian, Papua New Guinea, and the Solomons.[20] Another intercept indicated that the IJN carrier *Kaga* would participate in the campaign. Other messages indicated possible participation by the light carrier *Shoho* and the two large fleet carriers, *Shokaku* and *Zuikaku*. This revelation came from traffic analysis and still involved some guesswork.[21] Intercepts indicated that the three carriers, currently in home waters off Yokosuka, had significantly increased communications with Japanese positions in Truk and Rabaul. Though message content never revealed such, Hypo's traffic analysts concluded that the only possible reason for such communication was an impending offensive in the southwest Pacific.[22]

On April 18, the Doolittle raid, launched from the USS *Hornet*, accompanied by the USS *Enterprise*, bombed five Japanese cities, including Tokyo. The psychological effect was far greater than the bomb damage. One consequence was a "... greatly increased volume of [Japanese radio] traffic, much of it from units normally sending few dispatches, which provided Navy radio intelligence a line-up of Japanese fleet organization far superior to anything worked out previously."[23]

On April 24 and 29, intercepts revealed the Japanese target to be "MO." CDR Rochefort and his analysts, joined by their colleagues at FRUMEL,[24] early on had pinpointed Port Moresby as the primary objective of the RZP operation. At the end of April, Hypo cryptanalysts translated Yamamoto's Operation Order No. 1, which validated their previous estimates.[25]

As a result of COMINT "Nimitz was able to get Carrier Task Forces 16 and 17 under VADM "Bull" Halsey, with carriers *Lexington* and *Yorktown* on the scene in time..."[26] *Yorktown* had on-board a tactical radio intelligence unit. But hearability was spotty.[27]

On May 7 IJN aircraft sank the fleet oiler USS *Neosho* and destroyer USS *Sims*. In a counterattack US Navy aircraft sank the light carrier *Shoho*. The next day each opposing force located the other and launched all-out strikes. About evenly matched, both sides handed out heavy blows, the Japanese sinking the *Lexington* and damaging the *Yorktown*. US Navy aircraft badly damaged the *Shokaku* and severely depleted the *Zuikaku's* aircraft strength. The encounter forced the IJN to withdraw from the Coral Sea. The battle forestalled the Japanese invasion of Port Moresby. Communication Intelligence had proven itself.[28]

-rzp-campaign/#more-4865. Also Philip H. Jacobsen. "Foreknowledge of Pearl Harbor? No!: The Story of the US Navy's Efforts on JN-25B," *Cryptologia*, Vol. 27, No. 3, 2003. p 203. *https://stationhypo.com/2019/02/14/traffic-analysis-part-3-of-4/#more-10480. https://stationhypo.com/2019/02/15/traffic-analysis-part-4-of-4/#more-10482.*

18. "Tracking the Imperial Japanese Navy," *https://stationhypo.com/2017/06/02/path-to-midway-tracking-the-imperial-japanese-navy-part-3-of-5/*. Australian forces on New Britain were defeated by early February 1942.

19. Prados, p 284-5.

20. *https://stationhypo.com/2016/05/27/path-to-midway-tactical-loss-strategic-victory/. https://stationhypo.com/2017/04/17/part-1-of-5-battle-of-coral-sea-what-was-the-rzp-campaign/.*

21. "You'd have to guess the gaps," CDR Rochefort later told the author Walter Lord. *https://stationhypo.com/2017/04/20/part-4-of-5-battle-of-coral-sea-guess-the-gaps/.*

22. *https://stationhypo.com/2016/05/27/path-to-midway-tactical-loss-strategic-victory/#more-228.*

23. Biard, *https://stationhypo.com/2016/12/26/capt-biard-doolittle-raid-and-the-battle-of-coral-sea-part-3-of-4/#more-3057*, Prados, p 155. For a history of the Doolittle Raid see Peter C. Oleson. "The Doolittle Raid," When Intelligence Made a Difference, *The Intelligencer*, Vol. 26, No. 1., 2020.

24. FRUMEL – Fleet Radio Unit Melbourne was the reconstituted Station Cast after its evacuation from Corregidor. FRUMEL was integrated with the Australians and British SIGINT units.

25. *https://stationhypo.com/2017/04/18/part-2-of-5-battle-of-coral-sea-what-did-mo-designate/#more-4881*, *https://stationhypo.com/2016/05/27/path-to-midway-tactical-loss-strategic-victory/#more-228.*

26. USS *Enterprise* and USS *Hornet* needed refitting after the Doolittle raid and could not get to the Coral Sea in time for the battle. *https://stationhypo.com/2017/04/17/part-1-of-5-battle-of-coral-sea-what-was-the-rzp-campaign/#more-4865.* Forrest R. Baird. "Breaking of Japanese Naval Codes: Pre-Pearl Harbor to Midway," *Cryptologia*, Vol. 30, No. 2, April 2006, p 156.

27. RI Unit Post mission report, 23 May 1942. "Battle of Coral Sea – Post Radio Intelligence (COMINT) Mission Report" *https://stationhypo.com/2019/05/04/radio-intelligence-unit-post-mission-of-battle-of-coral-sea/.*

28. *https://stationhypo.com/2017/04/21/part-5-of-5-battle-of-coral-sea-the-battle/#more-4922.*

Battle of Midway

"In the spring of 1942, Japanese intercepts began to make references to a pending operation in which the objective was designated as 'AF.' Rochefort and Captain Layton believed 'AF' might be Midway since they had seen 'A' designators assigned to locations in the Hawaiian Islands. Based on the information available, logic dictated that Midway would be the most probable place for the Japanese to make its next move. Nimitz, however, could not rely on educated guesses."[29] Besides by the end of April JN-25 intercepts also indicated interest in the Aleutians.[30] SIGINT clearly pointed to a new Japanese offensive.

A disagreement between Hypo and OP-20-G in Washington developed over the Japanese objectives. "Washington said the [Japanese] move would be toward Fiji – Samoa – New Caledonia, while [Hypo analysts were] convinced that everything was pointing to Midway" (and the Aleutians as a feint). "Rochefort found solidly verifiable arguments that Midway was to be in early June; Washington still insisted that date was much too early."[31] On 26-27 May Hypo solved the date-time garble table "used to encipher dates inside the JN-25 system." It indicated targets as the Aleutians – 3 June, Midway – 4 June, and Midway occupied – 7 June.[32] This "finally gave Admiral Nimitz the exact time… sequence for the various moves in the Aleutians – Midway Operation!"[33]

How to convince the doubters in Washington? Via submarine cable, which could not be intercepted, Honolulu sent a message to Midway instructing it to radio Pearl Harbor in the clear that the salt-water evaporators on the base had broken down. Two days later, on May 22, a Japanese message was intercepted that reported "AF" was running out of fresh drinking water. "That's not how we found out Midway was the target, [though] it's often interpreted that way," Professor Craig Symonds clarifies. "We knew…or Rochefort knew, anyway. Rochefort did it to help convince Washington that he knew what he was talking about."[34]

On May 27 the Japanese Navy changed both its codebook and cipher. US Navy radio intelligence went deaf cryptanalytically and had to rely on HFDF and traffic analysis. However, one intercept in late May by FRUMEL indicated Japanese abandonment of naval attack on Port Moresby. This allowed Nimitz to recall Halsey's carriers from Coral Sea on May 16.[35] FRUMEL also compiled an order of battle for the IJN fleet being assembled.[36]

Nimitz had little room for error. His 3 aircraft carriers, 45 fighting ships, and 25 submarines were all that lay between Hawaii and the West Coast and the large Japanese Fleet that had yet to suffer a significant defeat. It appeared that Nimitz would have one shot at the enemy.[37] SIGINT kept him well informed. He had a good idea of the composition of the Japanese forces; he knew of the plan to station a submarine cordon between Hawaii and Midway; and he knew about the planned seaplane reconnaissance of Oahu, which never took place because he prevented their refueling at French Frigate Shoals."[38] On 28 May, with no intercepted IJN carrier transmissions, Hypo concluded they were at sea.[39]

On June 3 Japanese naval aircraft attacked Dutch Harbor in the Aleutians. This was followed by the occupation of the islands of Kiska and Attu on June 6 and 7. The US Navy's Task Force 8 sent to defend Alaska did not engage the Japanese.

On June 4 at 0604L a US Navy reconnaissance flight spotted two IJN carriers and "many planes heading Midway from 320 distant 150 miles."[40] USS *Yorktown* was one of three carriers with a RI unit aboard. "[I]ntercepts did confirm that the enemy fleet was in the area." "Once radio silence was broken by the enemy the unit intercepted a literal deluge of enemy traffic…" The RI unit warned of imminent enemy air

29. Patrick D. Weadon. *How Cryptology enabled the United States to turn the tide in the Pacific War.* NSA, Center for Cryptologic History.
30. Biard, "Breaking of Japanese Naval Codes," p 156.
31. Biard, "AF is Midway," *https://stationhypo.com/2016/12/27/capt-biard-af-is-midway-part-4-of-4/#more-3063*.
32. Biard, "Breaking of Japanese Naval Codes," p 157.
33. Biard, "Breaking of Japanese Naval Codes," p 153.
34. Craig L. Symonds, *The Battle of Midway*, Oxford University Press. 2011, p 182-8. Symonds was a professor at the Naval War College and chairman of the History department at the Naval War College. Sarah Pruitt, "How Codebreakers Helped Secure US Victory in the Battle of Midway," *https://www.history.com/news/battle-midway-codebreakers-allies-pacific-theater*; Erik Dahl. *Intelligence and Surprise Attack: Failure and Success from Pearl Harbor to 9/11 and Beyond*, Washington, DC: Georgetown University Press, 2013, p 58-9.
35. MacArthur suggested a deception to Nimitz of having US Navy ships simulate transmissions of a task force remaining in the Coral Sea area. Halsey's task force returned to Pearl Harbor under radio silence. The US knew "…Japanese RI easily learned of carrier movements in and out of Pearl harbor simply by monitoring air-ground radio chatter." See Frederick D. Parker. *A Priceless Advantage: US Navy Communications Intelligence and the Battles of Coral Sea, Midway, and the Aleutians*. National Security Agency, United States Cryptologic History. Series IV, World War II, Vol. 5, 2017, p 48.
36. Prados, p 318.
37. Patrick D. Weadon. "The Battle of Midway: How Cryptology enabled the United States to turn the tide in the Pacific War." NSA brochure.
38. Henry F. Schorreck. *Battle of Midway: 4-7 June 1942: The Role of COMINT in the Battle of Midway*. Designated as SRH-230 in the U.S. National Archives, Washington, D.C. Text available at *https://www.history.navy.mil/content/history/nhhc/research/library/online-reading-room/title-list-alphabetically/b/battle-midway-4-7-june-1942-srh-230.html*.
39. Parker, p 53.
40. Parker, p 56.

attack at during the day, often before on-board radars picked up attacking formations.[41]

Sequence of the Battle of Midway[42]

June 3, 1942

- Aircraft from Midway locate IJN transport task force 600 miles west of island. B-17 attack results in no damage.
- ~Midnight — US Navy patrol plane reports location of main IJN strike force.

June 4

- 0534 — US Navy PBY patrol plane from Midway detects Japanese task force.
- 0630 — IJN aircraft bomb Midway. Many US Marine Corps fighters lost.
- 0710 — 6 TBF Avenger torpedo bombers and 4 USAAF B-26 bombers from Midway attack IJN striking force of 4 carriers with 248 total aircraft, 2 battleships, 2 heavy cruisers, 1 light cruiser, and 12 destroyers.
- 0755 - 0820 – Dive bombers and B-17s from Midway attack IJN task force.
- 0925 — 15 torpedo bombers from *Hornet* attack.
- 0930 — 14 torpedo bombers from *Enterprise* attack.
- 1000 — 12 torpedo bombers from *Yorktown* attack. Almost all torpedo bombers were lost to IJN fighters and anti-aircraft fire. No hits were scored.
- 1025 — 30 dive bombers from *Enterprise* attack *Kaga* and *Akagi*. *Kaga* was hit four times and fatally damaged. *Akagi* was consumed by an uncontrollable fire from ignited aviation fuel.
- 1025 — 17 dive bombers from *Yorktown* attack *Soryū*. Struck three times, secondary explosions quickly doomed the ship.
- 1205 — First attack on *Yorktown*. Left disabled by 3 hits from dive bombers from carrier *Hirjū*.
- 1330 — *Hiryū* detected; 24 dive bombers take off from *Enterprise* against *Hiryū*.
- 1331 — 10 Kates and 6 Zekes take off from *Hiryū*.
- 1340 —*Yorktown* again in service, making 18 knots.
- 1430 — Second attack on *Yorktown*. At 15:00 *Yorktown* abandoned after suffering three torpedo hits.
- 1610 — *Soryū* sinks.
- 1700 — Dive bombers from *Enterprise* attack *Hiryū*. Four hits leave the carrier engulfed in flames.
- 1925 — *Kaga* sinks.

June 5

- 0500 — *Akagi* scuttled.
- 0900 — *Hiryū* hulk sunk by IJN destroyers.

June 6

- Dive bombers from *Enterprise* and *Hornet* sink 1 cruiser and 2 destroyers.
- Japanese submarine sinks *Yorktown*, which was being salvaged, and destroyer USS *Hammann*.
- Both fleets withdraw.

Conclusion

June 4-6 was a disaster for the Japanese. The lack of radio transmissions from their carriers confirmed to Nimitz pilot reports of the scope of the victory. "At Midway, the Imperial Navy lost all four aircraft carriers involved in the assault, as well as more than 300 aircraft and as many as 3,000 men, including some of their most experienced pilots."[43] Possibly more important was the loss of skilled aircraft maintenance personnel.[44] Most historians view the battle as the turning point in the war in the Pacific.

"After the battles of Coral Sea, Midway, and the Aleutians, the invaluable contributions made by communications intelligence were recognized by senior naval officials in Washington and Honolulu. In their words, communications intelligence had given the United States a 'priceless advantage' over the Japanese."[45]

There is an irony to the events of Coral Sea and Midway. Before the war both the IJA and IJN broke diplomatic ciphers of Britain, US, USSR, China and

41. "Battle of Midway, post radio intelligence (COMINT) report," *https://stationhypo.com/2019/06/04/post-battle-of-midway-radio-intelligence-comint-report/#more-11494*.
42. Derived from William Koenig (edited by S.L.Mayer). *Epic Sea Battles*. Secaucus, NJ: Chartwell Books, 1975, and Prados.
43. Pruitt.
44. Prados, p 337.
45. Parker, p 60, quoting from E.B. Potter. *Nimitz*. Annapolis. MD: Naval Institute Press, 1976

France.[46] "...[W]hen the Japanese Army's code breakers not only managed to decipher American machines at times, but discovered that the Americans were reading Japanese naval codes, the army failed to provide the navy with either the means to break these codes or the warning that its own codes had been compromised."[47] The IJN did not know until 1945 that the IJA had broken US ciphers.[48]

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46. Ken Kotani. *Japanese Intelligence in World War II*. New York: Osprey Publishing, 2009, p 5, 13-5.
47. Kotani, p viii.
48. Kotani, p 72.

"The big picture: 2020 will enter the history books among other anni horribili, which tended to concentrate disease and starvation.

- Take 1816, known as the "Year Without a Summer" thanks to a massive volcanic eruption in 1815, which caused what one historian called "the last great subsistence crisis in the Western world."
- Or 1349, perhaps the worst year of the Black Death pandemic, which would eventually kill a third or more of Europe's population alone.
- Don't forget 536, which the journal *Science* memorably called "the worst year to be alive." A volcanic eruption in Iceland early that year cast Europe and parts of the Middle East and Asia into a literal dark age.

— Mike Allen
in *Axios PM Report*
23 December 2020