

Pacific Islands Pilot.

VOL. I.

THE WESTERN GROUPS COMPRISING
THE TERRITORY OF PAPUA INCLUDING THE
LOUSIADE ARCHIPELAGO, THE NORTH-EAST
AND NORTH COASTS OF NEW GUINEA, THE
SOLOMON ISLANDS, THE BISMARCK ARCHI-
PELAGO, AND THE CAROLINE AND MARIANAS
ISLANDS

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CHAPTER X

CAROLINE ISLANDS AND MARIANAS OR LADRONES ISLANDS

Charts 763, 764.

CAROLINE ISLANDS.—The principal islands are the Palau group, Yap, the Truk group, Ponape, and Kusaie (*Lat. 5° 19' N., Long. 163° 00' E.*); of these, Yap is formed of aqueous rock, and the others are volcanic; they are all surrounded by fringing or barrier reefs. The other islands belong to the coral island type. 5

Those islands westward of long. 148° E. are called the West Caroline islands, and include over 190 islands and islets and those eastward of long. 148° E. are called the East Caroline islands. They include about 370 islands and islets. 10

Tidal streams.—Currents.—In the West Caroline islands, the tidal streams generally follow the configuration of the land and set eastward and westward. In places where no effects of the ocean currents are felt the west-going stream flows from 0 to 2 hours after low water until 0 to 2 hours after high water, and the east-going stream from 0 to 2 hours after high water until 0 to 2 hours after low water. Except in narrow channels the streams are very weak. 15

In the east Caroline islands the tidal streams are very weak and irregular, and are much affected by the ocean currents. Amongst these islands there are atolls with one or two small passages, at the entrances to which the flood stream sets inwards and the ebb outwards. They turn generally at the times of high and low water, and sometimes run strongly. In the open sea tidal streams are not experienced. 20

Inside the atolls, the direction of the tidal streams is irregular, generally owing to the existence of reefs or islands; they seldom flow along the axis of the entrance channel, so that caution is necessary when entering or leaving. 25

For general remarks on currents in the region of the Caroline islands see page 10.

Chart 977, plan of Palau islands.

WEST CAROLINE ISLANDS:—Palau islands.—Palau islands, situated at the western end of the Carolines, consist of a large island, named Babelthaup, near the northern end, six smaller islands, and numerous islets, some of these latter rising vertically to an elevation of 600 feet (182^m9). 30

The whole of the group, with the exception of Angaur, the southernmost island, is situated on coral reefs. The northern end of the group is formed by several off-lying detached reefs; the eastern side is for the greater part fringed by reef, and the western side is flanked by about 50 miles of broken barrier reef, the westernmost point of which is about 6 miles from the nearest island. 35

Chart 781.

Chart 977, plan of Palau islands.

The islands southward of Babelthuap are coral reefs; of these, Peleliu and Angaur island (*Lat. 6° 54' N., Long. 134° 09' E.*) are, on the whole, flat, but on the others there are narrow hills sloping steeply seaward. On all these hilly islands there has been erosion at the water's edge by the sea, forming grottoes.

The principal industries are fishing and the production of copra; there is an iron foundry on Koror. In 1953, the population of Palau was 7,297, and in 1943, there were about 9,000 natives on Babelthuap.

Anchorage.—The principal anchorage is in Malakal harbour (page 536); other well-sheltered anchorages are in Koror harbour (page 538), and Kobasang harbour (page 540), and there are less protected anchorages in Western lagoon (page 540), Koror road (page 536), and Arangel channel (page 537).

Chart 763.

Currents.—**Tidal streams.**—Between Palau islands and Yap (page 544), the North Equatorial current flows from December to May. The current generally sets in a westerly direction at rates of up to one knot or more. From June to November the easterly countercurrent is usually met in this region. Southward of Palau islands to about lat. 2° N. the easterly countercurrent flows in all months of the year. Rates up to 2 knots are frequently experienced and rates of between 2 and 3 knots are occasionally found. The countercurrent is least constant in direction in the period of March to May.

The currents and tidal streams in the vicinity of Angaur island are very irregular. In 1911, it was reported, by s.s. *Ferndene*, that between this island and Peleliu, they set eastward and attained a rate of from 3 to 4 knots at springs.

In the various channels amongst the Palau islands the tidal streams turn approximately at the times of high and low water.

In July, 1926, the Japanese man-of-war *Manshu*, experienced a west-south-westerly current of about one knot, about 10 miles southward of Angaur island.

Chart 977, plan of Angaur island.

Angaur island.—Angaur island, a densely wooded island, is steep-to, except off the south-western extremity, where a reef extends for a distance of about half a mile north-westward; there are no anchorages available.

Angaur harbour.—**Light.**—**Towers.**—Angaur harbour, a port of entry of the Palau group, is situated on the western side of Angaur island; there is a pier at Saipan, on the western side of the island, about half a cable long, from which vessels load phosphate; during the season of westerly winds a heavy swell sets in and the harbour is unsafe. Mooring buoy, No. 1, is laid about $3\frac{1}{4}$ cables westward of the head of the loading pier. In 1945, there were several cranes with lifting capacities of from 5 to 11 tons.

There is a hospital at the settlement.

A light is occasionally exhibited, close south-eastward of the loading pier on the western side of Angaur island.

There is a tower about one cable within the eastern extremity of the island, and another $3\frac{1}{4}$ cables farther westward. An old lighthouse is situated 2 cables southward of the northern extremity of the island. There is a white shrine on the north-western point of the island.

Chart 781.

Chart 977, plan of Palau islands.

Peleliu.—Banks.—Buoys.—Beacon.—Peleliu is a wooded and fertile island, 265 feet (80^m8) high, at its northern end, lying at the southern extremity of the barrier reef, about 6 miles north-eastward of Angaur island. About midway between them is a bank with a least depth of 52 feet (15^m8) over it. A bank, with a least depth of 48 feet (14^m6) over it, lies 3 miles eastward of the northern extremity of Angaur island. On the reef, which nearly dries, extending from the northern end and north-eastern side of Peleliu there are several islets. There are some wharves on the north-eastern side of the island. 5

A causeway extends from the western extremity of the island, and a yellow mooring buoy is situated north-westward of it, with a warping buoy about 2 cables seaward of the mooring buoy 10

A white beacon, 42 feet (12^m8) high, stands at the southern end of the island. 15

A reef, on which is Ngarmoked islet (*Lat. 6° 58' N., Long. 134° 14' E.*), extends about half a mile southward from the southern extremity of Peleliu.

There is a boat basin, with a depth of 8 feet (2^m4), on the western side of the southern end of the island, and there is another boat basin at the northern end. A channel, dredged to a depth of 6 feet (1^m8), marked by beacons, leads from the latter basin to Schonian harbour (*see below*). It is reported that the boat basin is obstructed with sunken dangers and should be entered with caution. 20

Ngesebus islet lies on the coastal reef about 3½ cables northward of Peleliu. 25

Barnum bay.—Beacons.—Barnum bay is an indentation in the coastal reef about 1½ miles northward of Ngesebus islet; it is about one mile wide at its entrance and extends about 2 miles north-eastward. The depths in the bay are considerable, and the reefs on either side are steep-to. On either side of the entrance is a white beacon and several islets. At the head of the bay a narrow shallow inlet marked by buoys leads to the entrance of a boat channel, which is dredged to a depth of 6 feet (1^m8), leading eastward to Schonian harbour. 30

Eil Malk.—Eil Malk or Amototi, a wooded island, 452 feet (137^m8) high, lies 7½ miles north-eastward of Peleliu. The coast is remarkably rugged except on the eastern side, and is fringed by a narrow reef. Cape Aitaburai, the south-eastern extremity of the island, is 272 feet (82^m9) high; its eastern side is grey and fairly conspicuous. 35

A hill, 374 feet (114^m0) high, and wooded on its summit, nearly one mile from the northern end of the island, is noticeable from southward. 40

Schonian harbour, south-westward of Eil Malk, affords a well-sheltered anchorage from north-easterly winds for vessels with local knowledge; part of the harbour has been swept to a depth of 55 feet (16^m8). 45

Denges passage leads into Schonian harbour from eastward between the reefs extending from the southern side of Eil Malk and the northern side of Ngeregong, a low wooded coral island, on which stands a beacon, about 1½ miles southward. The passage has been swept to a depth of 29 feet (8^m8), and is marked by beacons and buoys. 50

Yoo anchorage, situated north-eastward of Eil Malk, is protected from westward and northward by Eil Malk and Urukthapel, respectively; the greater part has been swept to a depth of 55 feet (16^m8). There are two wide passages leading to the anchorage from eastward, 55

Chart 977, plan of Palau islands.

the southern of which has been swept to a depth of 36 feet (11^m0).

Yoo passage, between Eil Malk and Urukthapel, about 1½ miles northward, has a least depth of 10 fathoms (18^m3), but is little used.

- 5 On the northern side of Yoo passage, 1½ miles north-north-eastward of the northern extremity of Eil Malk, is Abeyabu islet, on which there was, in 1944, a conspicuous tree.

Tidal streams.—The tidal streams attain a rate of 3½ knots in Denges passage, and 3½ knots in Yoo passage.

- 10 **Urukthapel.**—**Tower.**—Urukthapel is a rugged, densely wooded island, 670 feet (204^m2) high; the island is free from fringing reef. There are a few beaches, backed by steep ridges covered with dense growth.

A white circular stone tower (*Lat. 7° 15' N., Long. 134° 27' E.*), 15 25 feet (7^m6) in height, is situated on the eastern extremity of Urukthapel.

- Off-lying dangers.**—Kasao reef, which dries from 2 to 4 feet (0^m6 to 1^m2), is the southernmost of a chain of reefs extending about 4½ miles from Ngaremediu point, the south-eastern extremity of Urukthapel.

Chart 977, plan of Malakal harbour and Koror road.

- Nakano shō, with a depth of 3 feet (0^m9) over it, lies nearly 1½ miles east-south-eastward of the tower on Urukthapel. A chain of shoals, with depths of from 12 to 33 feet (3^m7 to 10^m1) over them, extends 25 about 1½ miles south-westward from Nakano shō.

- Koror road.**—**Dangers.**—Koror road is an open anchorage lying between the reefs extending north-eastward from the eastern end of Urukthapel, and the western side of Augulpelu reef, the south-western point of which lies 4 miles eastward of the eastern extremity of Urukthapel.

From Nakano shō a chain of shoals and reefs extends about 3½ miles north-eastward to the western extremity of Augulpelu reef.

- Mutomdu reef, with a depth of 3 feet (0^m9) over it, lies about 2 miles north-eastward of Nakano shō, with patches with depths of from 10 to 35 36 feet (3^m0 to 11^m0) over them, between. A shoal, with a depth of 29 feet (8^m8) over it, lies about 6 cables south-eastward of the tower on Urukthapel, and two shoals, each with a depth of 42 feet (12^m8) over it, lie about 6 cables east-south-eastward and eastward, respectively, of the tower.

- 40 **Anchorage.**—Temporary anchorage may be obtained in Koror road north-westward of the chain of shoals extending from Nakano shō to the western end of Augulpelu reef, in depths of from 12 to 17 fathoms (21^m9 to 31^m1).

- Malakal harbour.**—**Dangers.**—**Beacons.**—**Buoys.**—Malakal harbour, north-westward of Koror road, is safe and well sheltered by the surrounding high land; it is protected by Urukthapel on the south-west, Ngargol and Auluptagel on the north-east, and Ngadarak reef on the south. Malakal, an island (*Lat. 7° 20' N., Long. 134° 27' E.*), 401 feet (122^m2) high, lies in the middle of the northern side of the 50 harbour, and is joined by a reef at its north-eastern end with the northern extremity of Auluptagel.

On the summit of Malakal there is a steel structure painted in mottled yellow stripes.

The harbour may be approached by vessels of medium size with local

Chart 977, plan of Malakal harbour and Koror road.

knowledge from south-eastward through Koror road, and thence through Malakal passage and Ngell channel, on the south-western and north-eastern sides, respectively, of Ngadarak reef. Large vessels with local knowledge may approach from westward through Toagel Mlungui passage (page 540).

Auluptagel, an island, 607 feet (185^m0) high, with a beacon on its summit, is steep and densely wooded, except on the western side of the peninsula extending northward from its northern side, where there is a plantation.

Malakal is fringed by a reef which extends about a quarter of a mile southward from its southern extremity; a reef also extends 3½ cables south-south-eastward from the south-eastern side of the island.

No. 23 beacon, a white circular concrete structure, stands on the outer extremity of the reef which extends from the south-eastern side of Malakal.

Ngargol is a steep island, 227 feet (69^m2) high, without any fringing reef, except at its eastern extremity, which lies about 4 cables northward of the eastern extremity of Malakal.

Several detached reefs, the positions of which may best be seen on the chart, are marked by beacons or buoys.

Sunken moorings are situated about 6½ cables eastward of the southern extremity of Malakal; vessels should not anchor in this position.

Koror.—Arakabesan.—Koror, an island, 492 feet (150^m0) high within about 6 cables of its southern extremity, lies close north-eastward of Auluptagel. The southern part of the island is rugged, steep and densely wooded; the western part is generally level, about 100 feet (30^m5) high, and bordered with mangrove swamps in places; the northern side is fringed by a reef, which dries, extending as much as half a mile offshore.

The town of Koror (*Lat. 7° 20' N., Long. 134° 29' E.*) stands on the northern side of the island near its western end. The population of the island, in 1952, was reported to be over 6,000. On the eastern and western sides of the town are, respectively, the districts of Ebaduls and Madalai.

Two radio towers, each 150 feet (45^m7) high, situated about 3½ cables east-north-eastward of the western extremity of Koror, are prominent.

Arakabesan, an island, 372 feet (113^m4) high, and wooded at its north-western end, lies northward of Ngargol; in the southern part of the island is a hill, 359 feet (109^m4) high, with a beacon on it. The island is fringed by a reef, which dries at the eastern end.

Koror, Arakabesan, Auluptagel and Malakal are joined to one another by causeways.

Wharves.—Piers.—The greater part of the coast of Malakal is bordered by wharves. There is a concrete pier extending from the eastern side of Malakal which will accommodate three vessels, 400 feet (121^m9) in length, and has a least depth of 32 feet (9^m8) alongside except the extreme inner end, where the water shoals abruptly. The northern side of the pier is damaged near the inner end, and should be approached with caution.

At Madalai (*Lat. 7° 20' N., Long. 134° 28' E.*) there are several concrete wharves, with depths of 4½ fathoms (8^m7) alongside; they can

Chart 977, plan of Malakal harbour and Koror road.

be approached by small vessels through a narrow channel, marked by beacons, with a depth of 7 feet (2^m1) in it, or through a channel, with a depth of 2 fathoms (3^m7), marked by beacons between Auluptagel and Ngargol, leading to Station harbour.

Ebaduls pier extends northward from the northern side of Koror, about one mile eastward of the western extremity; it is 1,680 feet (512^m0) long, and at its outer end between two arms there is a boat basin, in which there is a depth of 8 fathoms (14^m6). It is reported that vessels up to 10,000 tons can lie alongside. There is a 50-ton pontoon lighter and two travelling cranes at Koror.

Entrance channels.—Light.—Buoys.—Beacons.—Malakal passage, which has been swept to a depth of 22 feet (6^m7), is about half a cable wide, and is marked by buoys and beacons. A light is exhibited from a white concrete tapered tower, 24 feet (7^m3) in height, on the south-western side of the entrance to Malakal passage.

No reliance should be placed on the beacons in this passage as they are liable to be washed away.

There is a patch, with a depth of 2 fathoms (3^m7) over it, lying on the eastern side of the northern end of the passage.

Ngell channel is unmarked and should not be used by vessels without local knowledge.

Toagel Mid passage, entered about 2½ miles east-north-eastward of the entrance to Ngell channel, lies between the reefs fringing the eastern side of Koror and the southern side of Babelthuap, and connects Arangel channel at the southern end with Koror harbour at the northern end. The passage, which has been swept to a depth of 33 feet (10^m1), should not be used by vessels without local knowledge. A red spherical buoy marks the northern side of the coastal reef at the northern entrance to the passage, and is moored about 1¼ miles north-eastward of the summit of Arakabesan (page 537).

Arangel channel is connected to Koror road by a passage which has been swept to a depth of 49 feet (14^m9).

Anchorage.—Directions.—Anchorage may be obtained, in depths of from 10 to 14 fathoms (18^m3 to 25^m6), sand, in Malakal harbour. The lighthouse on the eastern side of Urukthapel was reported, in 1944, difficult to identify when approaching from south-eastward, but there were several prominent white marks on the bluff on which it stands.

A vessel approaching Malakal passage from eastward should pass about 4 cables north-eastward of Nakano shō, (Lat. 7° 15' N., Long. 134° 28' E.), and thence steer for the entrance to the passage. It is recommended to arrive at the entrance about the time of low water, when the tidal stream is slack.

Anchorage may be obtained by vessels with local knowledge, in depths of from 15 to 25 fathoms (27^m4 to 45^m7), sheltered from all except westerly winds, in Kobasang harbour, south-westward of Arakabesan.

Koror harbour, on the northern side of Koror, affords anchorage to vessels with local knowledge, sheltered from all except north-westerly winds.

Prohibited areas.—A prohibited area extends across Toagel Mid passage in the vicinity of the north-eastern extremity of Koror.

A prohibited area, the south-western corner of which is marked

Chart 977, plan of Malakal harbour and Koror road.

by a red spherical buoy, surmounted by a flag, lies westward of Arakabesan, and southward of Ngurur, an islet about 4 cables north-westward of the north-western extremity of Arakabesan.

Vessels are prohibited from anchoring within 656 feet (200^m0) of Nos. 1 and 2 mooring buoys in Malakal harbour, situated about 7 cables eastward and 8 cables east-south-eastward, respectively, of the southern extremity of Malakal island.

Tidal streams.—In Malakal passage the north-going stream has a rate of 2½ knots and the south-going stream 2 knots; it is reported, however, that they sometimes attain a rate of from 4 to 5 knots. In the narrow part of the channel, the tidal streams set directly through, and outside attain considerable strength; the south-going stream has been observed to set at a rate of over 3 knots for five days after new moon, causing a strong tide race for some distance off the entrance. North-eastward of Channel point, on the eastern side of Urukthapel, about 1½ miles within the entrance to the passage, the stream sets across the channel.

In the inner part of Toagel Mid passage, the tidal streams have a rate of from 2 to 2½ knots.

Harbour facilities.—A modern hospital is maintained at Koror.

Communication.—**Radio station.**—Koror is connected to the general telegraph system.

There is a radio station at Koror. See page 39.

Chart 977, plan of Palau islands.

Babelthuap.—Babelthuap, the largest island of the Palau group, has a range of hills, which attains an elevation of 794 feet (242^m0), extending along the middle of the island. There are numerous forests, the largest of which covers the north central and east central parts of the island. Mangroves border the coasts, except along the northern end of the eastern side, where there are a few sand beaches.

The most prominent mark on the island is the 643-foot (196^m0) summit on the western side about 10½ miles north-north-westward of Arudowaishi point, the south-eastern extremity; this summit appears as a broad flat dome with a sharp peak beside it. A radio tower stands about 7 miles north-north-westward of Arudowaishi point, and six radio towers, 125 feet (38^m1) in height, situated westward of Airai, 2½ miles westward of Arudowaishi point, are distinctive.

Barrier reef.—**Passages.**—**Beacons.**—**Buoys.**—A barrier reef, extending about 2½ miles offshore, fronts the south-eastern side of the island, commencing one mile east-south-eastward of Arudowaishi point, and terminating about 2 miles southward of Melekeiok point (Lat. 7° 30' N., Long. 134° 39' E.), situated 8½ miles north-north-eastward. Melekeiok village stands on the latter point, and a pier extends south-eastward nearly to the edge of the fringing reef.

The lagoon enclosed by this barrier reef may be entered through Goraklbad passage, which has been swept to a depth of 49 feet (14^m9), but the reefs in the lagoon are little known, and the patches among them are numerous, rendering navigation in some places intricate, so that a vigilant look-out aloft is necessary.

The openings in the barrier reef northward of Goraklbad passage are only suitable for boats.

In 1883, H.M.S. *Espiegle* entered the lagoon, and passing along the eastern coast of Babelthuap, anchored southward of Melekeiok.

Chart 977, plan of Palau islands.

From Melekeiok point to Cape Arukoron, the northern extremity of the island, the coast is fringed by reef which extends from about a quarter of a mile to one mile offshore, but from Cape Arukoron, it extends $5\frac{1}{2}$ miles northward and about $2\frac{1}{2}$ miles eastward.

About $3\frac{1}{2}$ miles northward of this projecting reef is the southern extremity of Kossol reef, and $2\frac{1}{2}$ miles westward of Kossol reef is North-west reef, 2 miles southward of which is the north-western extremity of Cormoran reef. The area enclosed by these reefs is called Kossol passage, and is well protected from the ocean swell, but the depths in it are irregular, with a sand and coral bottom, and there are several shoal patches, the positions of which may best be seen on the chart.

A framework beacon, 15 feet (4^m6) in height, stands on the edge of the reef on the southern side of the entrance to Kossol passage, about $5\frac{1}{2}$ miles north-north-eastward of Cape Arukoron. A similar beacon, 25 feet (7^m6) in height, stands on the edge of the reef on the northern side of the entrance, 4 miles farther north-north-eastward.

Kawasak passage is entered between the northern end of the reef extending northward from Cape Arukoron, and the south-eastern end of Cormoran reef, and extends along the western side of Babelthuap inside the barrier reef which fronts this coast, as far as the western entrance to Malakal harbour. The passage is tortuous and there are many sunken reefs, but a passage has been swept to a depth of over 10 fathoms (18^m3) as far as Ngardmau bay, $7\frac{1}{2}$ miles south-south-westward of Cape Arukoron, which should only be used by vessels with local knowledge. The tidal streams in Kawasak passage are sometimes strong.

There are two piers at Ngardmau, the principal settlement in Babelthuap, situated at the southern end of Ngardmau bay, the north-eastern of which has a depth of 9 feet (2^m7) at its head. Bauxite is mined in the vicinity, and this is the main industry of the island.

Aiwokako passage, entered 7 miles south-westward of Cape Arukoron, has a least depth of 6 fathoms (11^m0), and has been swept to depths of from 24 to 28 feet (7^m3 to 8^m5).

Toagel Mlungui, entered $14\frac{1}{2}$ miles south-south-westward of Cape Arukoron (*Lat. $7^\circ 44' N.$, Long. $134^\circ 37' E.$*), is the southernmost passage through the barrier reef on the western side of Babelthuap. From it a channel has been swept to a depth of 55 feet (16^m8), passing through Western lagoon, between the barrier reef and the western side of the island, leading to Kobasang, Malakal and Koror harbours.

A white beacon, surmounted by a red diamond shape and red reflector, stands on the southern side of the entrance to the passage; two white beacons, bearing 105° , lead through the outer part of the passage, thence two white beacons situated southward of Arumaten point, in line, bearing about 146° , mark the turning point for vessels proceeding southward. The channel leading further southward is marked by beacons and buoys.

A rock, 9 feet (2^m7) high, lies on the barrier reef northward of Toagel Mlungui, $2\frac{1}{2}$ miles north-westward of Arumaten point, and Gesodokkuru rock, 6 feet (1^m8) high, lies on the reef, on the southern side of the passage, about $3\frac{1}{2}$ miles westward of the same point.

A red buoy is moored $2\frac{1}{2}$ miles south-westward of Ngaregabal, an islet, situated about 8 miles south-south-westward of Arumaten point:

Chart 977, plan of Palau islands.

a patch, with a depth of 15 feet (4^m6) over it, about 2 miles further south-westward, is marked on its eastern side by a red can buoy.

Anchorage.—Piers.—Anchorage may be obtained, in a depth of about 10 fathoms (18^m3), in Kossol and Kawasak passages. 5

Anchorage may be obtained by vessels with local knowledge, in depths of from 8 to 25 fathoms (14^m6 to 45^m7), in Ngardmau bay, sheltered from all except westerly winds.

Charts 763, 781.

Islets and dangers northward of Babelthuap.—Kayangel islets 10 consist of four low islets covered with coconut palms, lying on a reef, 1½ miles northward of Kossol reef, being separated by Kayangel passage, in which there are no known dangers. Inside the lagoon there is a general depth of less than 6 fathoms (11^m0), and there are many reefs, but it is suitable for small craft with local knowledge during 15 easterly winds, which can enter through a boat passage on the western side of the atoll.

A shoal, with a depth of 31 feet (9^m4) over it, lies half a mile eastward of Ngajangel, which is 92 feet (28^m0) high to the tops of the trees, and is the northernmost of the Kayangel islets. 20

Ngaruengl reef (*Lat. 8° 10' N., Long. 134° 38' E.*) is an atoll lying about 5 miles north-westward of Kayangel atoll. Inside the lagoon there is a general depth of about 1½ to 3 fathoms (2^m7 to 5^m5), but there are many reefs. There are no known dangers in Ngaruengl passage, the channel between the two atolls, and it is reported to be a 25 safe route for vessels approaching the western side of the Palau group from eastward.

Chart 763.

Velasco reef is a sunken atoll extending about 17 miles northward from Ngaruengl reef; the least depths, about 6½ fathoms (11^m9), 30 are on the edges of the reef. When the tidal streams are strong there are overfalls on the outer edge of the reef, and even when it is calm there is sometimes a choppy sea, but it is difficult to make out from a distance, so that caution is necessary when approaching it.

Chart 977, plan of Sonsorol islands. 35

Outlying islands and reef south-westward of Palau islands.—**Buoy.**—Sonsorol are two islands lying about 150 miles south-westward of Angaur island. They consist of Sonsorol, 118 feet (36^m0) high to the tops of the trees, the larger of the two, and Banna, 109 feet (33^m2) high to the tops of the trees, one mile northward of it; both islands are 40 surrounded by a fringing reef extending from about one to 3 cables, and both are thickly wooded with coconut palms and other trees.

A red mooring buoy is situated close westward of the fringing reef about the middle of the western side of Sonsorol island. 45

The channel between the two islands is about 6 cables wide and is free from dangers.

Chart 763.

A bank, with a depth of 13 fathoms (23^m8), which has not been examined, was reported, in 1944, to lie about 70 miles south-westward 50 of Angaur island.

Current.—In July 1926, the Japanese man-of-war *Manshū* experienced a south-easterly current of about 3 knots when about 8 miles eastward of Sonsorol island. On proceeding southward, the

Chart 781.

Chart 763.

rate of the current gradually decreased until in the vicinity of Tobi (see below) it ceased.

Chart 977, plan of Pulo Anna.

- 5 **Pulo Anna.**—Pulo Anna, 43 miles south-south-westward of Sonsorol island, is surrounded by a fringing coral reef, which extends about a quarter of a mile from its northern and eastern sides. The island is densely wooded, the tops of the trees having an elevation of 63 feet (19^m2).

- 10 In 1894, H.M.S. *Pallas* was unable to obtain anchorage off Pulo Anna, there being no bottom at a depth of 150 fathoms (274^m3); at a distance of 2 cables offshore.

North-eastward of the island a strong east-going tidal stream has been experienced. It has been reported that in the vicinity of the island, a current sets east-south-eastward at a rate of from half a knot to 3 knots. Tide-rips have also been reported northward of the island.

The island lies in the flow of the Equatorial counter current throughout the year.

Chart 977, plan of Merir island.

- 20 **Merir.**—**Current.**—Merir island, 92 feet (28^m0) high to the tops of the trees, lies about 29 miles south-eastward of Pulo Anna. It is surrounded by a fringing reef which extends about 6½ cables from its southern end and about one cable from its northern end; the edges of the reef are steep-to, except at the northern end where a spit, with a depth of 7 fathoms (12^m8) over its outer end, extends about three-quarters of a mile northward; it is reported that sailing vessels sometimes anchor here.

A boat can reach the lee side of the southern end of the island at high water.

- 30 A current, setting south-eastward at a rate of 1½ knots, has been reported southward of Merir island. In 1946, a vessel reported a current setting south-eastward at a rate of over 2 knots between Merir island and Pulo Anna.

Chart 977, plan of Tobi or Kodogubi island.

- 35 **Tobi.**—**Current.**—Tobi or Kodogubi island, lies about 104 miles south-westward of Merir island. It is covered with coconut palms, the tops of which attain an elevation of 118 feet (36^m0), and is fringed by a reef, which at its northern end, extends about 4½ cables north-eastward. Landing can be effected on the western side of the island, but in westerly winds caution is necessary.

Most of the houses are situated on the south-western side of the island, where, it is reported, there are some piers and mooring buoys, with a dredged channel leading to one of the piers, alongside which a vessel of 2,800 tons has berthed.

- 45 In 1930, the natives were friendly, and many understood English. Tobi island lies in the flow of the Equatorial countercurrent throughout the year, and the current in the vicinity has been reported to set south-eastward at a rate of about 1½ knots.

Chart 977, plan of Helen reef.

- 50 **Helen reef.**—Helen reef, about 35 miles eastward of Tobi island, is surrounded by a narrow belt of coral on which the sea breaks heavily. Helen islet (Lat. 2° 59' N., Long. 131° 49' E.), which is 42 feet (12^m8) high to the tops of the trees, thickly wooded, and uninhabited, lies at the northern end of the reef. At high water when the sea is smooth

Chart 977, plan of Helen reef.

there are sometimes no breakers on the reef, so that it is dangerous to approach it at night.

Although the reef is generally dry at the lowest tides, there is a channel into the lagoon near the middle of the western side. For about 2 hours before and after high water the reef can be crossed by boat on the western side, and a landing can be effected on the western side of the islet.

Tidal streams.—Current.—The tidal streams setting over Helen reef are strong. When the tide is falling, the water flows out of the lagoon over the reef in all directions until the reef is uncovered, and then flows out through the channel on the western side; when the tide is rising, the reverse takes place. At the end of the ebb and the beginning of the flood, the tidal streams in the channel are strong, but as only few parts of the reef completely dry, the maximum rate does not exceed about $1\frac{1}{4}$ knots.

In March, 1918, an easterly current was reported throughout the whole of this vicinity.

Chart 977, plan of Ngulu or Lamoliaur Ulu islands.

Ngulu islands.—Ngulu or Lamoliaur ulu islands, consisting of several islets on an atoll reef, lie about 170 miles east-north-eastward of the northern extremity of Babelthuap of the Palau group. The chain of reefs on the southern and western sides of the atoll afford complete protection to the lagoon from the sea; the reefs on the eastern side are submerged, so that with strong easterly winds, a swell sets into the lagoon.

Ngulu islet, 98 feet (29^m0) high to the tops of the trees, is densely covered with coconut palms; it lies at the southern extremity of the atoll and is the only inhabited islet of the group. North islet, near the northern end of the atoll, is low and covered with coconut palms. Between these two islets the reef is in detached patches, and does not break during westerly winds.

There are channels on either side of Ngulu islet. East passage, on the eastern side, has been swept to a depth of 23 feet (7^m0) over a least width of one cable. West passage, entered about three-quarters of a mile north-westward of the islet, has been swept to a depth of 52 feet (15^m8). Uatschaluk islet, on the eastern side of the atoll, bearing $075\frac{1}{2}^\circ$ leads through West passage.

Döroppu passage, about 4 miles north-north-westward of Ngulu islet, has been swept to depths of 39 and 50 feet (11^m9 and 15^m2); a course of 041° leads through the passage. There are several other channels into the lagoon on the southern and western sides, but they are all narrow.

Tidal streams.—In Döroppu passage the flood stream sets in at a rate of half a knot and the ebb sets out at a maximum rate of $1\frac{1}{4}$ knots. In West passage both the flood and ebb streams have a rate of up to $2\frac{1}{4}$ knots. In East passage the flood and ebb streams attain rates of from three-quarters of a knot to 2 knots, but their directions are irregular.

Anchorage may be obtained on the northern side of Ngulu islet. During north-westerly and south-easterly winds a swell sometimes sets in but generally the sea is smooth, and it is reported to be a good anchorage. At high water a landing can be effected on the northern side of Ngulu islet (*Lat. $8^\circ 18' S.$, Long. $137^\circ 29' E.$*).

