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REPORT 49

CHLORINITY AND TEMPERATURE DISTRIBUTION IN DECEPTION BAY, QUEENSLAND, 1968 - 69

By B. S. Newell

Marine Laboratory
Cronulla, Sydney
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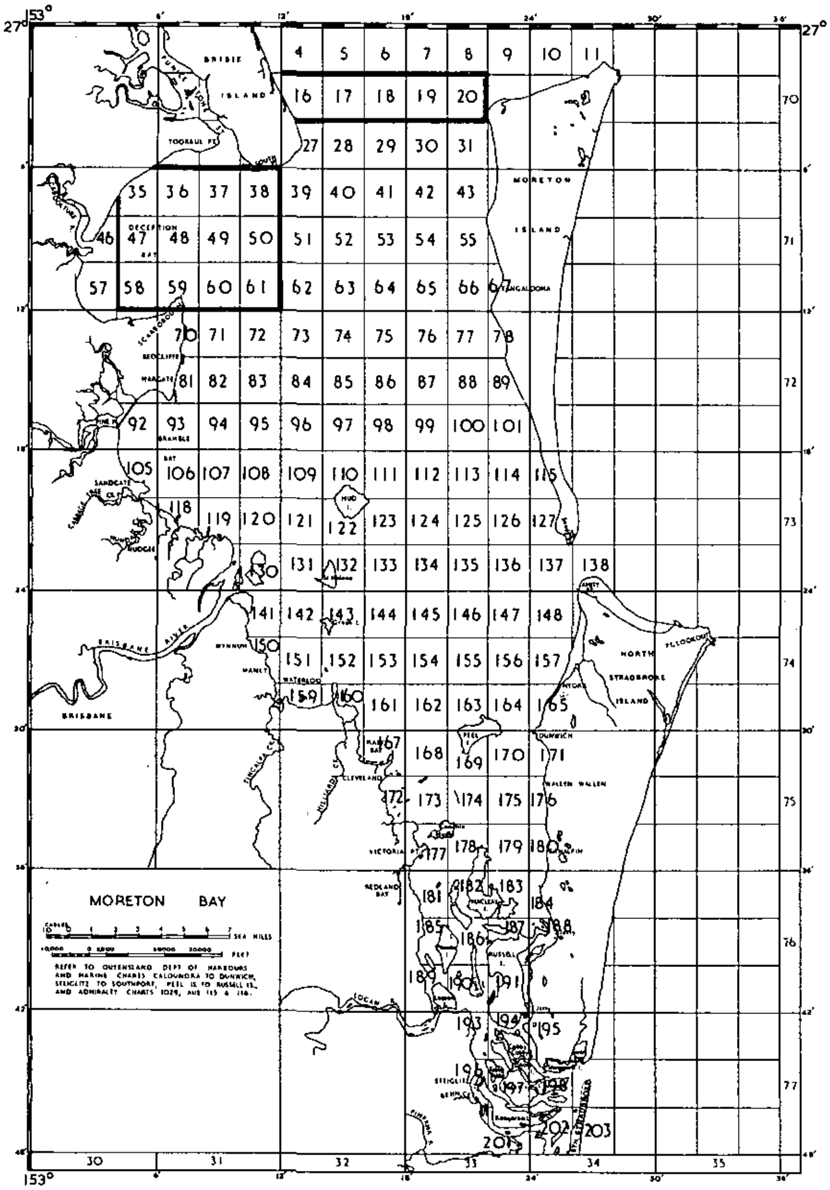

Fig. 1. - Chart of Moreton Bay, showing location of sampling stations in Deception Bay (35-61) and the northern section (16-20)

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I. INTRODUCTION

During 1967 and 1968, five surveys were made by CSIRO Division of Fisheries and Oceanography in Moreton Bay, Queensland. The results have been described by Newell (1971). These surveys gave principal coverage to the central and southern zones of the Bay and indicated that the dispersal of river input probably occurred by eastward mixing across the Bay. Some data from Deception Bay and the northern zone suggested an escape of brackish water northwards past Bribie Island, but coverage of this zone was scanty.

The measurements described in this report were designed to investigate this phenomenon more closely, and to provide, in addition, more knowledge of temperature and chlorinity changes in Deception Bay itself, where the new Queensland Fisheries Research Institute is sited.

II. METHODS

All measurements were made with a CSIRO meter (Hamon 1956) at 1 m intervals from surface to bottom.

The sampling pattern was based upon the numbered grid developed by QFRI (Fig. 1). A list of the grid stations sampled is given in Table 1. Data obtained along the line Station 60-66 from June to September 1968 have not been used in this report.

All data collected have been lodged with the Australian Oceanographic Data Centre, Sydney.

III. RESULTS

a. Northern Section

The changes in mean temperature and chlorinity at each station from July 1968 to June 1969 (no measurements were made in November 1968) are shown in the form of a T-Cl diagram (Fig. 2).

TABLE 1

GRID STATIONS AT WHICH MEASUREMENTS OF CHLORINITY AND TEMPERATURE WERE MADE EACH MONTH FROM JULY 1968 TO JUNE 1969

Month	Day	Northern Section	Deception Bay	Southern Section
July	10	16,17,18,19,20		60,61,62,63,64,65,66
Aug.	6	Ditto		Ditto
Sep.	3	Ditto	35,36,37,38,47,48 49,50	Ditto
Oct.	9	Ditto	35,36,37,38,47,48 49,50,58,59,60,61	
Nov.	11	(No sampling)	Ditto	
Dec.	16	Ditto +27	Ditto +39	
Jan.	14	Ditto	Ditto	
Feb.	11	Ditto	Ditto	
Mar.	11	Ditto	35,36,37,38,47,48 49,50,59,60,61	
Apr.	9	Ditto	35,36,37,38,47,48 49,50,58,59,60,61	
May	6	Ditto	35,36,37,38,49,50 59,60,61	
June	23	Ditto	35,36,37,38,47,48 49,50,58,59,60,61	

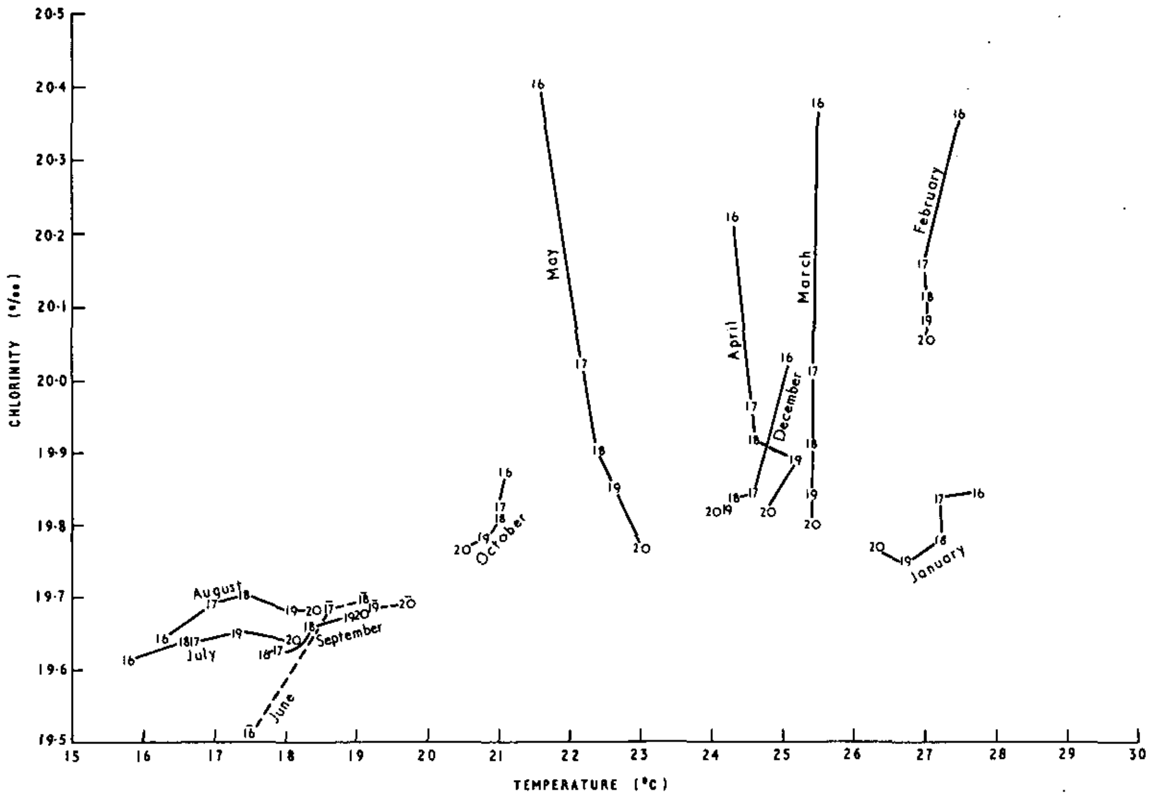

Fig. 2. - Temperature-chlorinity diagrams for northern section, July 1968 to June 1969 (November, no data). Numerals indicate coordinates of mean T-Cl value for each station (16-20).

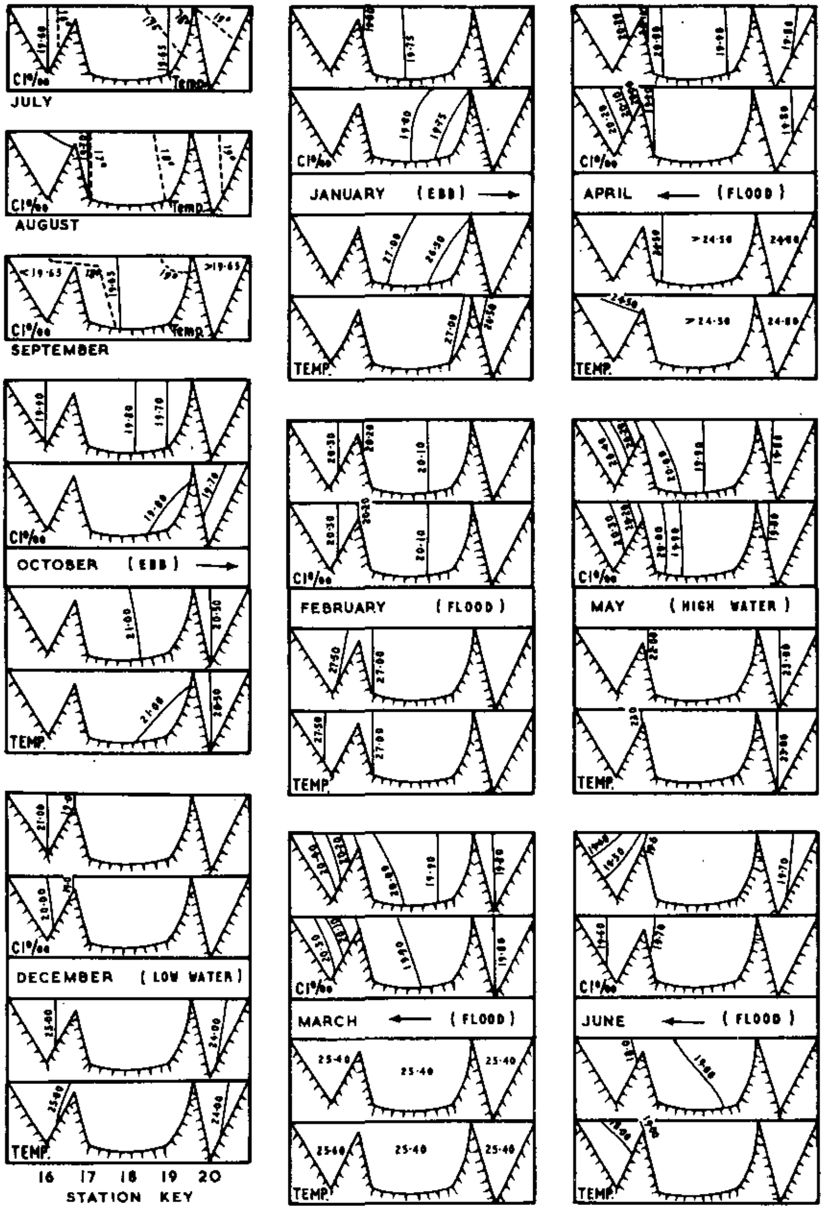

Fig. 3. - Vertical (east-west) sections through stations 16-20 from July 1968 to June 1969 (November, no data). Showing distribution of isotherms and isochlors, with tidal shift east or west in October, January, March, April and June. July to September 1968, single section only, isotherms dashed. Others double section (see text). Isochlors at 0.1‰ intervals unless otherwise labelled.

Clearly shown is an annual temperature cycle, with lowest values in July-August and highest values in January-February. During the winter months, June to September, temperatures increased from west to east, whilst in January this gradient was reversed. In the intervening months, little or no gradient was found.

The survey coincided with two periods of low rainfall and low flow in the Caboolture River (Table 2). Increases in rainfall and river flow produced corresponding falls in chlorinity along the northern section after about one month's delay. The effect of drought conditions is shown by the rise in chlorinity values from September to December and from January to March. Rain in December and May produced a fall in chlorinity values in January and June. During the drought, or high chlorinity periods, chlorinities were higher in the west of the section, with maximum gradients in March and May. The December rainfall, whilst lowering chlorinities in January, did not reverse this trend. However, higher rainfall in July, August, and May did produce lower chlorinities in the western end of the section in July, August, September, and June.

The vertical distribution of properties along the northern section is given month by month in Figure 3. This figure shows the delta structure across the northern end of Moreton Bay, with Station 16 lying in the westernmost channel, Stations 17, 18, and 19 in the middle channel, and Station 20 in the eastern channel. Transfer of water between channels may occur north and south of the section through the ramification of the delta system (Newell 1971, Fig. 1).

When it became apparent, by September, that the properties at Station 16 were usually different from those of Station 20, implying a continual presence of Bay water in the western and middle channels, the sampling pattern was altered. The southern section had so far shown a T-Cl distribution similar to those encountered in the previous survey, and was dropped. Instead, the northern section was repeated each sampling day, the ship proceeding from Station 16 to Station 20 and back again. This gave a time separation of 2 to 3 hours between measurements at Station 16 with, of course, correspondingly smaller time intervals at Station 17, 18, and 19. It was hoped that this time separation might indicate the influence of tides upon the amount of Bay water present in the section.

Figure 3 shows five occasions on which sampling was conducted on a flood tide (February, March, April, May, and June). In March, April, and June, a westward shift of isochlors occurred between samplings. In April and June but not March this was accompanied

TABLE 2

RAINFALL AT SANDGATE (IN.), CABOOLTURE RIVER OUTFLOW (acre/feet) MEAN CHLORINITY AT STATIONS 16, 20, AND THE WESTERNMOST DECEPTION BAY STATIONS (1) AND THE DIRECTION AND VELOCITY OF THE MEAN WIND FOR 3 DAYS PRIOR TO SAMPLING

Month	Rainfall (in.)	River Acre/Feet	Mean Chlorinity at Stations			3-day Wind	
			Group 1	16	20	Knots	Dir.
June	0.12	170					
July	1.09	310		19.61	19.65	9	E
Aug.	2.72	270		19.62	19.68	3	E
Sep.	0.15	80	19.61	19.62	19.67	4	SE
Oct.	0.17	80	20.01	19.90	19.67	3	E
Nov.	1.93	90	20.41			3	E
Dec.	3.50	2,000	20.23	20.06	19.82	3	SE
Jan.	1.55	10	20.31	19.86	19.77	1	E
Feb.	1.84	150	20.60	20.36	20.05	3	NE
Mar.	1.80	20	20.91	20.44	19.80	7	SE
Apr.	1.15	10	20.81	20.26	19.81	4	S
May	12.02	5,490	20.65	20.42	19.77	7	SW
June	0.61	510	19.25	19.38	19.69	20	W

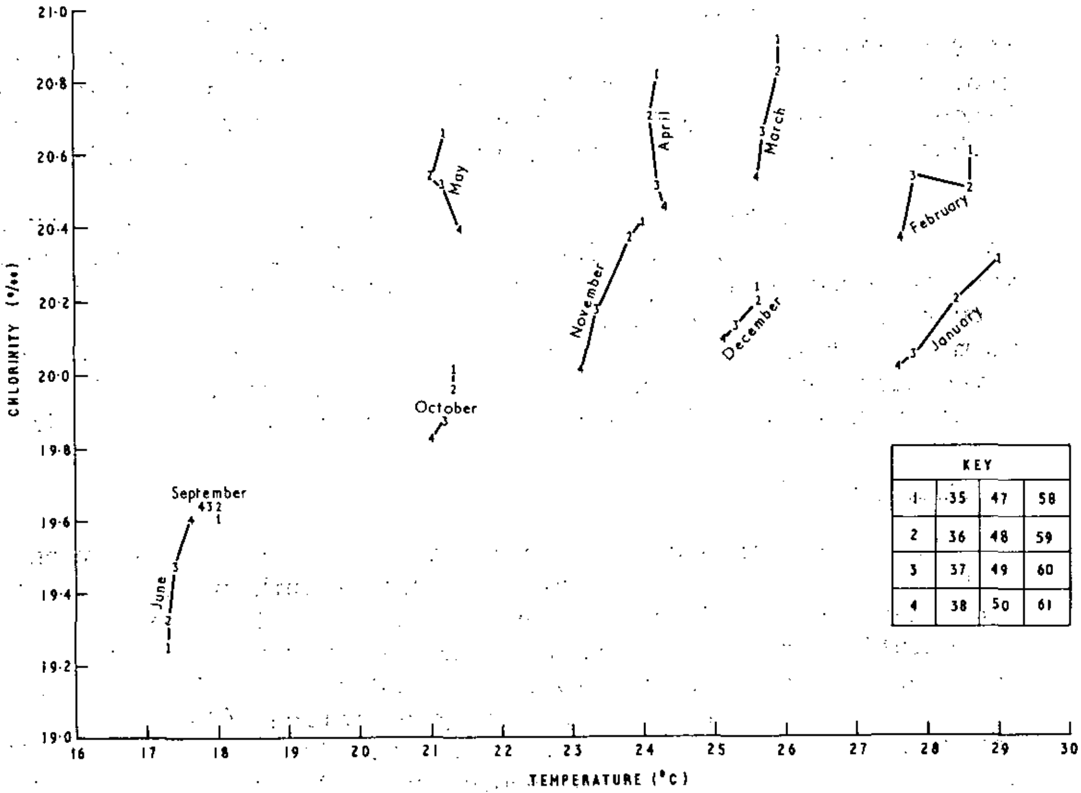

Fig. 4. – Temperature chlorinity diagrams for Deception Bay, September 1968 to June 1969. Numerals 1 to 4 indicate coordinates of mean T-Cl values for each four north-south rows of stations (see Key).

by a shift westwards of isotherms. In February and May no shift was observed. In October and January, sampling occurred on an ebb tide, and in both months an eastward shift of both isotherms and isochlors occurred between samplings. The December sampling was carried out either side of low water, and no shift of isotherms or isochlors was observed.

Whilst tidal influence was observed, it occurred on only 5 out of 8 samplings, and never resulted in the complete displacement from the section of either Bay water by oceanic water or vice versa. Hence it seems likely that efflux of Bay water northwards, whilst perhaps irregular, is continual rather than tide generated.

On all but three occasions, the water column was isothermal and isohaline at each station, so that vertical mixing was usually more profound than horizontal mixing, probably because of the delta structure. The exceptions were July, when warm ocean water tended to move westwards in the upper layers, January, when warm Bay water moved eastwards in the upper layers, and June, when brackish Bay water produced stratification at the western end of the section.

b. Deception Bay

The most pronounced difference in properties in Deception Bay occurred along an east-west axis. (North-south gradients were irregular, and are discussed further below.) In order to simplify presentation, the mean chlorinity and temperature for each north-south row of stations each month was plotted on a T-Cl diagram (Fig. 4). The westernmost row of grid stations (35, 47, and 58) are shown as 1, the next row (36, 48, and 59) as 2, the next (37, 49, and 60) as 3, and the easternmost row (38, 50, and 61) as 4.

Only in September was the Bay well mixed vertically and horizontally. From October to May an east-west chlorinity gradient was found, with the higher chlorinities in the west i.e. onshore. In June, this gradient was reversed. As in the northern section, the chlorinity gradient tended to fluctuate with rainfall and river flow (Table 2) except that high river flow produced an immediate fall in chlorinity at the westernmost stations (December and May/June) with a slow rise in chlorinity during the intervening drought periods.

An annual cycle of temperature occurred (Fig. 4) with lowest values in June and September and highest values in January and February. The western stations were warmer than the eastern from October to February. From March to June little or no temperature gradient existed.

The vertical distribution of chlorinity at all stations is shown in Figure 5 in the form of vertical sections. As in the northern section there was a tendency for vertical homogeneity at each station. Exceptions occurred in October and April, when high chlorinity water formed in the onshore shallows moved down and eastwards. The reverse phenomenon appears in June, when brackish water tended to move eastwards in the upper layers.

The vertical distribution of temperature at all stations is shown in Figure 6. Temperature stratification appeared more frequently than chlorinity stratification, being present in October, November, January, March, April, and June.

The presence or absence of stratification was not related to wind. Table 2 gives the mean wind, in knots, for the three days preceding sampling in each month. Winds were generally light (1-9 knots) and the only occasion of strong wind (20 knots) was in June, when both temperature and chlorinity stratification were very marked. The effect of the strong west wind in June was to drive warm brackish water offshore (Fig. 5, 6).

Isotherms and isochlors sloped in opposite directions during October, November, January, and April. A tentative explanation may be that nocturnal cooling in the shallow onshore waters caused saline water to sink and move offshore, whilst solar heating produced temperature stratification anew each day. The sampling was always carried out in the middle of the day.

The distribution of isotherms and isochlors in each month (Fig. 5, 6) was examined for evidence of water circulation. In most months there was a tendency for offshore water to intrude more along one section than another, but the temperature and chlorinity trends could not always be reconciled. Only in December and February could an unambiguous circulation trend be perceived. This was in a clockwise sense. However, it would seem likely that the real circulation pattern takes the form of gyrals of varying diameter probably powered by tidal shear, as in the main body of Moreton Bay (Newell 1971).

IV. CONCLUSIONS

Across the northern entrance to Moreton Bay there exists a pronounced gradient in temperature and chlorinity for most of the year, indicating the continual escape of Deception Bay water northwards past Bribie Island. This Bay water sometimes reaches right across to the easternmost end of the entrance.

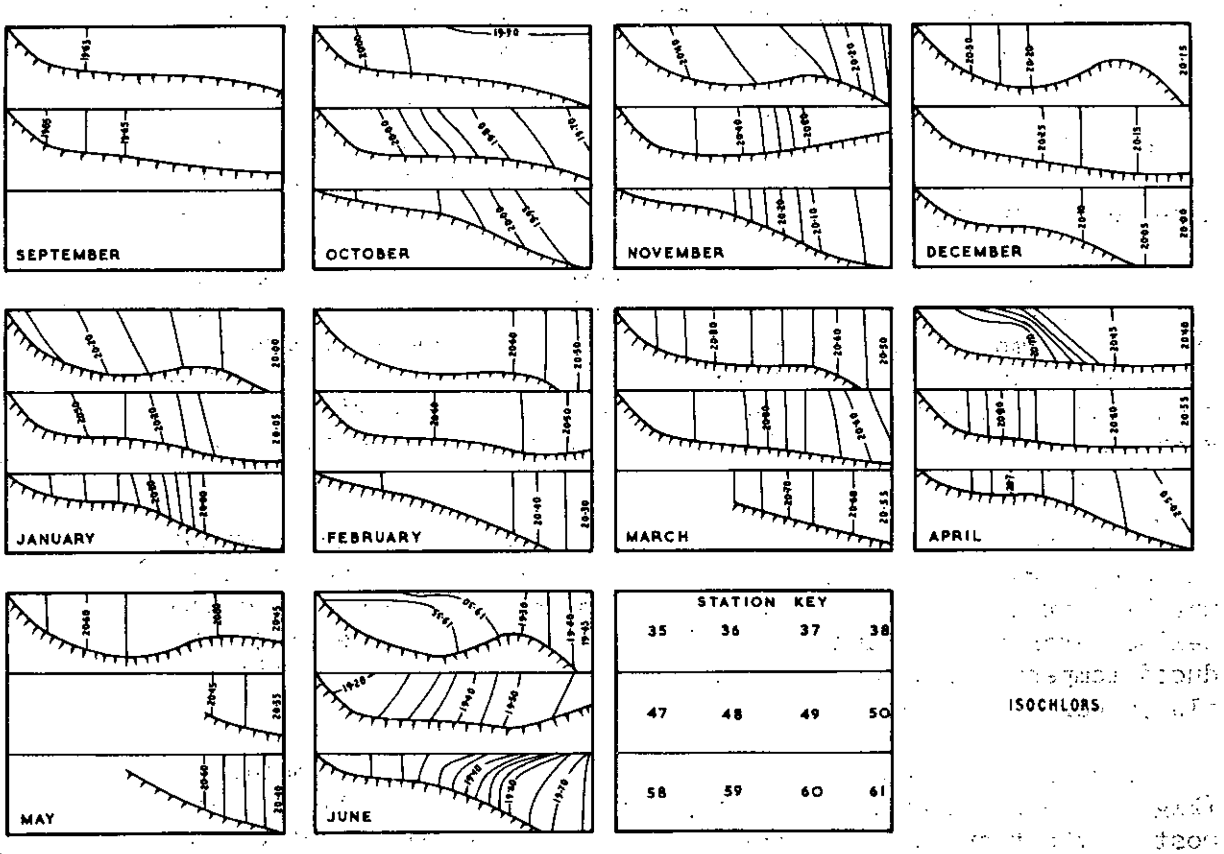

Fig. 5. – Vertical east-west sections through all stations sampled in Deception Bay (see Key) showing distribution of isochlors at 0.05‰ intervals.

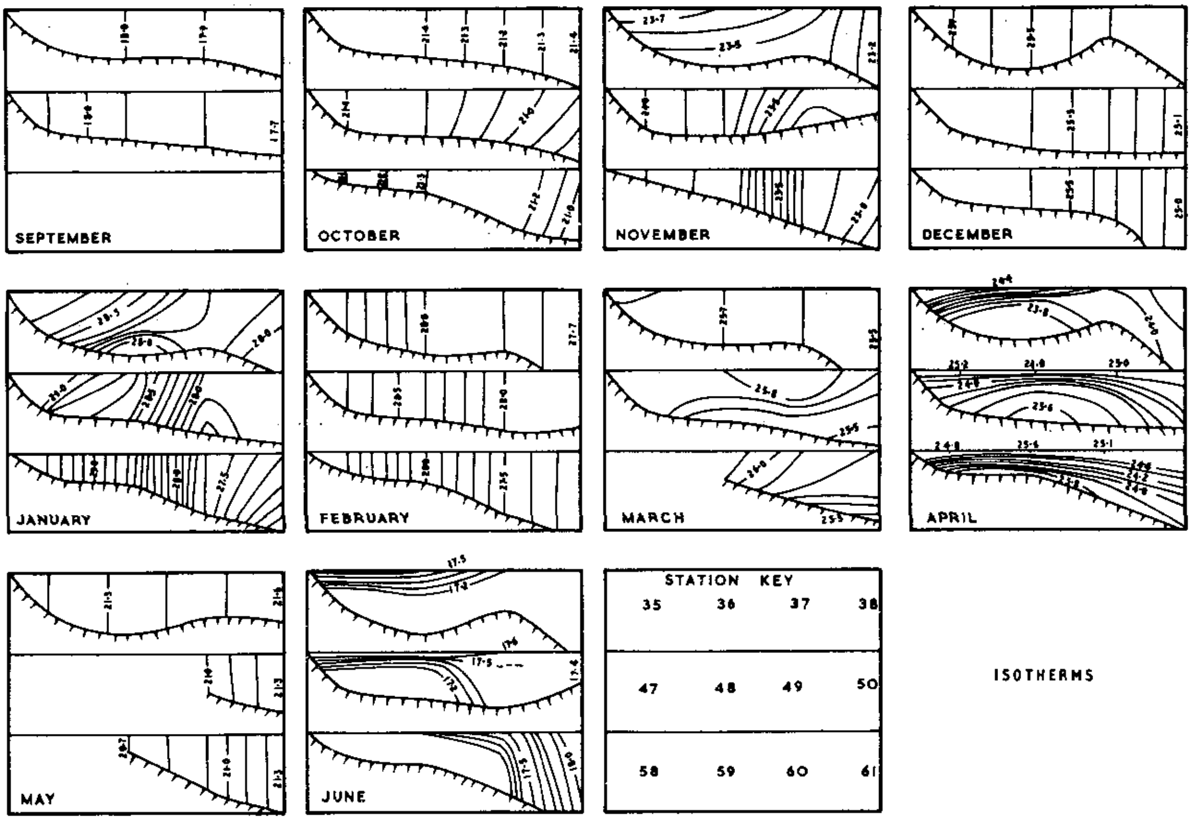

Fig. 6 - As Figure 5, showing distribution of isotherms at 0.1‰ deg.C intervals.

Deception Bay itself shows marked fluctuations in temperature and chlorinity with time as a response to river input or evaporation. Gradients in temperature and chlorinity are generally along an east-west axis, but some north-south differences also occur, probably as a result of the circulation pattern in the Bay. Temperature and chlorinity stratification sometimes appears as a result of brackish water outflow, evaporation, or insolation.

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