diethyl ether (*4*), and with the action of tetrabenazine (Nitoman, RO 1-9569) (*5*), a reserpine-like compound which produces similar effects of very short duration on brain 5-hydroxytryptamine and norepinephrine (*6*).

We have previously described the quantitative measurement of convulsion thresholds to hexafluorodiethyl ether (HFE) (*7*). The time required for this volatile convulsant to elicit preconvulsive myoclonic jerks or sustained clonic convulsions was measured after the application, every 30 seconds, of 0.05-ml increments of a 10-percent solution (in alcohol) of the convulsant to a gauze wick suspended in a 3.4-liter jar. Reserpine, tetrabenazine, α-MeDOPA, and α-MMT were given intraperitoneally to groups of ten or more mice at various intervals prior to the HFE test. Because one of the solubilizing vehicles (the benzyl alcohol-citric acid-polyethylene glycol 300 aqueous solution for reserpine) had a slight action on the convulsion thresholds, the action of each drug group was compared to that of its corresponding vehicle control group, and alterations in threshold were expressed as percentages of change from these controls.

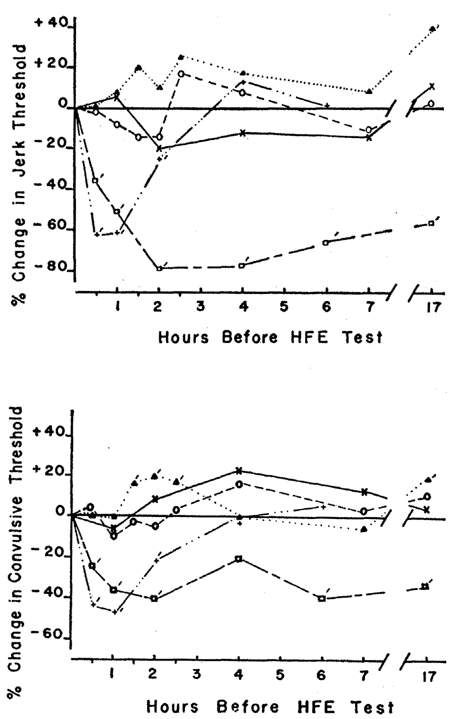

Fig. 1. Change in threshold from that of vehicle-control-group mice for preconvulsive myoclonic jerks (top) and clonic convulsions (bottom), produced by administration of hexafluorodiethyl ether at various intervals after intraperitoneal injection of drugs. / /, $p < .05$; O – – –, α-MMT (100 mg/kg); ▲ ——— – ———, α-MMT (500 mg/kg); × ———, α-MeDOPA (1000 mg/kg); □ . . . ., reserpine (10 mg/kg); + ——— . . . ———, tetrabenazine (75 mg/kg).

In Fig. 1 the changes in the thresholds for myoclonic jerks (top) and for clonic convulsions (bottom) are shown. Very large doses of α-MeDOPA and α-MMT do not produce a significant lowering of these convulsion thresholds at any time up to 17 hours. The larger dose of α-MMT produced significant threshold elevation at several points. In sharp contrast, reserpine and tetrabenazine markedly lowered jerking and convulsion thresholds to hexafluorodiethyl ether. Tetrabenazine, as anticipated from other studies (*6*), produced a short depression of convulsion thresholds and prolonged the effect of reserpine.

These results may be coupled with the observations of Porter (*2*) and Hess (*3*) that α-MeDOPA and α-MMT produce a greater and more prolonged depression of brain norepinephrine than of 5-hydroxytryptamine. The fact that those doses which have been shown by them to produce complete and prolonged depletion of norepinephrine do not lower the convulsion thresholds in the way that reserpine does strongly implicates the decrease in brain 5-hydroxytryptamine in the lowering of convulsion thresholds by reserpine. Smith (*8*) found that α-MeDOPA depletes norepinephrine in mouse brain less than it decreases 5-hydroxytryptamine in guinea pig brain, but his data are not fully comparable because he used subcutaneous injection of the drug and a bioassay determination of the amines. Brodie *et al.* (*9*) used dimethylaminobenzoyl methylreserpate (SU-5171) as a selective factor on 5-hydroxytryptamine and norepinephrine in rabbit brain and associated the decline in levels of 5-hydroxytryptamine in rabbit brain with the sedation produced by reserpine. Kuntzman *et al.* (*10*) employed α-MMT to further confirm this association. Although a causal relationship remains to be established, it appears that the lowered convulsion threshold and the central sedation of reserpine and other 5-HT releasing compounds may be temporally correlated with a decrease in brain 5-hydroxytryptamine.

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2 August 1961

Evidence for Oceanic Frontogenesis off Oregon

Abstract. Bathythermograms recorded off Newport, Oregon, show marked positive gradients during the period of cessation of summer upwelling. It is suggested that these are related to the formation of a shear zone or "front" between oceanic water and shelf water that has been exposed to the surface and modified.

Bathythermograms recorded in the northeastern Pacific Ocean often show positive gradients—that is, small but sharp increases of temperature with depth—at about 100 m. In fact, for waters north of 46°N, this has been shown by Bennett (*1*) to be the "normal" summer situation. Similar inversions are often found in waters farther south, including those along the Oregon coast. Presumably, most of these inversions are related to the depth and extent of cooling of the water during the previous winter, as suggested by Tully (*2*).

However, a recent set of observations off Newport, Oregon, showed an inversion that appeared to develop *in situ* during the summer, seemed to have a definite slope from one position to another, and occurred at temperatures between 8° and 11°C. In all of these respects it differed somewhat from the inversions that were described by Bennett.

An analysis of the data, analogous to the frontal concept used by meteorologists, fits the observations very well (see Fig. 1). It is suggested that per-

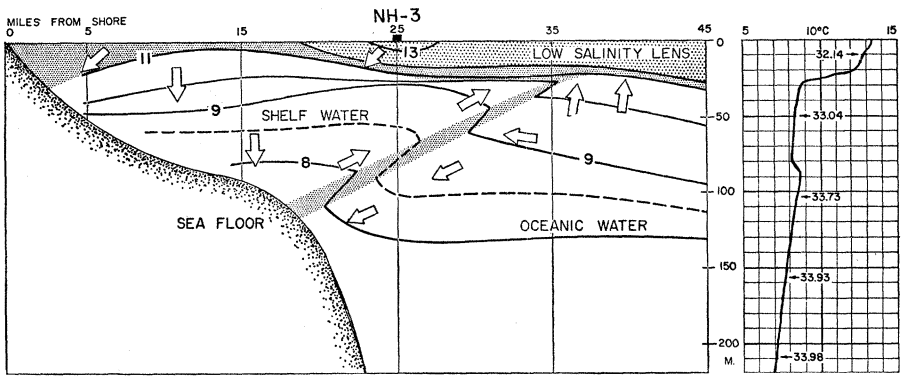

Fig. 1. (Left) Temperature-depth section off Newport, Oregon, during October 1960. (Right) A copy of the bathythermogram recorded in the center of the section, at the line marked NH-3. The salinity is given for the depths where it was measured.

haps this front (*3*) was real and constituted a boundary between oceanic water and shelf water that had been modified during and after summer upwelling.

Figure 1 illustrates the proposed analysis and shows (at right) a bathythermogram recorded in the center of the temperature-depth section, at station NH-3. The vertical lines in the section represent the sites of the observations; casts were to 200 m or to the bottom, whichever distance was less. The depths of the isotherms were determined from the various traces. When a positive gradient appeared, the positions and temperatures for the minimum and maximum were read. The arrows indicate changes that had occurred in the positions of the isotherms since the previous month. The lightly shaded water between the 11-degree isotherm and the surface is a local low-salinity water, separated by a sharp thermocline and halocline from the waters lying beneath it (the pycnocline is shaded more deeply). The sloping shaded zone represents the front.

Figure 1 shows conditions in October 1960; observations were made about once a month throughout the year and are continuing (*4*). No inversions appeared in the data for August; in September, inversions appeared in positions close to those shown in Fig. 1, and a frontal analysis similar to the one shown could be made. Between September and October the water below the thermocline, but above the front, cooled a few tenths of a degree centigrade. For a few meters below the front the water warmed a few tenths of a degree. At the two inshore stations the water all the way to the bottom was warmer in October than in September. Offshore, there was cooling at the surface but relatively little change below the thermocline. By late November, inversions appeared on the two offshore observations only, instead of on the two central ones, and inversions appeared again on the two offshore observations in January, but at somewhat deeper levels. No cruise was made during February; in March and April no inversions were found along this line.

The surface circulation in this region is wind-driven. Longshore currents to the south during the summer are accompanied by vigorous upwelling; alongshore water that is normally found at depths of 100 to 200 m appears at the surface. Usually in August this upwelling lessens, and occasional currents to the north are observed. During the fall and winter, northward-flowing currents are the rule. As these currents change, the distribution of mass near shore adjusts. As the upwelling lessens, warmer surface water moves inshore, and the water that upwelled previously runs down off the shelf to its more normal location. If, however, it has been modified at the surface by warming during the summer, and especially by mixing with low-salinity surface waters and local runoff, it will have characteristics different from those of the oceanic waters at the levels to which it returns. Under some circumstances it may override the saltier oceanic mass, as suggested in Fig. 1.

Data were also collected off Astoria and Coos Bay, about 100 miles north and south of Newport, respectively. Although occasional positive gradients appeared, they did not seem to indicate a continuous frontal surface, and there was no special coherence in pattern from one month to the next. The bottom slopes more steeply at each of these locations than it does off Newport, where there are shoals offshore. Perhaps these shoal areas played a significant part in maintaining the pattern observed in the Newport section.

This is not the only way in which isotherms can be drawn, of course, and the type of analysis may lead to some of the flow pattern suggested by the arrows. Furthermore, since positive gradients are frequent in the area, one cannot overlook the possibility that these were simply introduced either from the north or the south, or from offshore. Nevertheless, the analysis is consistent with all of the data, and the mechanism appears to be possible. (*5*).

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4. We are indebted to Bruce Wyatt of Oregon State University, who made the observations mentioned, for drawing our attention to the bathythermograms on which this report is based.
5. This work was supported by the Office of Naval Research.

21 August 1961

Uptake of Catecholamines by a Particulate Fraction of the Adrenal Medulla

Abstract. Chromaffin granules isolated from beef adrenal medulla took up C^{14}-labeled catecholamines from an isotonic medium at 37°C at a rate approximately 20 times the rate at 0°C. The uptake was stimulated three- to five-fold by Mg^{++} and adenosine triphosphate. Reserpine ($1 \times 10^{-5}M$) caused a 90 percent inhibition of uptake; ethylenediaminetetraacetic acid completely inhibited the stimulation by magnesium and adenosine triphosphate, and the inhibition could be reversed by addition of excess Mg^{++}.

The occurrence of catecholamines and adenosine nucleotides in the chromaffin granules of the adrenal medulla (in an approximate molar ratio of 4:1) has suggested that these compounds are associated in a non-diffusible complex within the granules (*1*). Previously Hillarp (*2*) reported that only small amounts of tritiated adrenaline were taken up by chromaffin granules at 0°C and attributed this small uptake to lack