Table 1. Comparison of pertinent features of this set of observations with previous observations at 97°W. The surface velocity, maximum eastward velocity, and depth of the core vary according to the speed of the average surface winds. The velocity is positive eastward.

Date of measurement	Surface velocity (cm/sec)	Maximum eastward velocity (cm/sec)	Depth of core (m)	Maximum shear from core to surface $\times 10^{-2}$ (sec^{-1})	Transport per unit cross section $\times 10^{5}$ (cm^2/sec)	Average surface winds (m/sec)
May 1958	~ 0	130	40	3.25	7.3	0.3–3.3
October 1961	− 68	87	65	2.40	7.7	3.4–7.9
April 1968	+ 78	143	30	2.27	22.8	0–1.5

and maximum velocities of the core are similar in the 1958 and 1968 profiles; on the 1961 profile the maximum speed is about 30 percent less and is located about 25 to 30 m deeper. The speed at the surface in the 1958 observations is not given, but, since no mention is made (*2*) of any eastward surface component, it must be assumed that it was either slightly westward or negligible [Fig. 6 (*2*) is unclear on this point]. In 1961 a westward surface current extended down to 30 m with a maximum westward component of 68 cm/sec at the surface. In contrast to this, the 1968 profile shows a strong eastward surface component of 75 cm/sec. Furthermore, in 1961 significant eastward flow extended only to 200 m, whereas in 1968 such flow reached 315 m.

The maximum shear calculated from the surface to the velocity core is surprisingly similar for all three profiles, averaging about 2.8×10^{-2} sec^{-1}. The transport per unit cross section at this location is about the same for the 1958 and 1961 observations; in 1968 it is more than three times those values. A comparison with calculations at more westerly locations on the equator (*3*) shows that the transport per unit cross section at 97°40′W in 1968 was greater than any previously measured, indicating significant variations in the strength of the current.

Cromwell *et al.* (*4*) first suggested that observations of eastward surface currents at the equator resulted from a subsurface eastward current (the Equatorial Undercurrent) reaching to the surface. They suggested that eastward ship drift close to the equator in the eastern Pacific and Atlantic, which was noted by Puls (*5*), might be caused by surfacing of the undercurrent that occurs when the wind stress is small.

Montgomery (*6*) summarized the observations of equatorial ship drift of Schott (*7*) in the Pacific and Krummel (*8*) in the Atlantic and concluded that those occurrences of eastward motion represent a surfacing of the Equatorial Undercurrent when the local trade wind fails. A direct observation of surfacing in the Atlantic was reported by Voigt (*9*) from current-meter measurements made on 21 and 22 May 1959 at 0°09′N,30°W. In his summary of observations of ship drift in the eastern tropical Pacific, Wyrtki (*10*) indicated eastward components between 110° and 98°W near the equator during the months of March and April. In the text accompanying the charts he stated that this eastward flow is probably a surfacing of the Equatorial Undercurrent in the absence of easterly winds.

The winds in the eastern equatorial Pacific vary seasonally, with maximum trade winds experienced in the late southern winter around August and a minimum in March (*11*). The three sets of observations discussed here reflect this pattern. Reported wind speeds during the 4 days spent between 106°57.5′ and 97°56′W in late May 1958 on the Dolphin Expedition (*12*) varied between Beaufort 1 and 2 (0.3 to 3.3 m/sec). On Expedition Swansong in October 1961, the winds were near a maximum for this area, varying between Beaufort 3 and 4 (3.4 to 7.0 m/sec) (*13*), whereas the recorded winds during the 5 days spent at the equator during the Eastropac Expedition were a minimum, varying between Beaufort 0 and 1 (0 to 1.5 m/sec).

It seems likely that the structure of the Equatorial Undercurrent in the eastern Pacific depends on the surface winds. The tendency of an easterly component of the wind to set up a shallow westward surface current appears to affect strongly the depth of the high velocity core of the undercurrent as well as the maximum eastward velocity and the transport per unit cross section. In extreme conditions when winds are slight, the westward surface current disappears and the Equatorial Undercurrent surfaces as observed in April 1968.

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25-Hydroxycholecalciferol: Stimulation of Bone Resorption in Tissue Culture

Abstract. *25-Hydroxycholecalciferol stimulates release of previously incorporated calcium-45 from fetal rat bones in doses of 0.9 to 27 units per milliliter. This effect cannot be produced by much larger doses of vitamin D_3. Comparison of stimulation of bone resorption by 25-hydroxycholecalciferol and parathyroid hormone reveals similarities with respect to time course, dose-response slope, and inhibition by calcitonin.*

Although there is substantial evidence that vitamin D stimulates bone resorption in vivo (*1*), attempts to demonstrate an effect in tissue culture have required large doses and have given inconsistent results (*2*, *3*). To

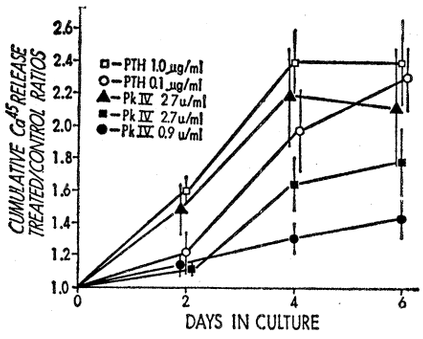

Fig. 1. Time course of the release of previously incorporated ^{45}Ca from fetal rat bones treated with either purified bovine parathyroid hormone (PTH) or 25-hydroxycholecalciferol (peak IV) in tissue culture. The shafts of the radius and ulna were dissected from 19-day fetal rats taken from mothers injected with 0.5 mc of ^{45}Ca on the previous day. The bones were cultured at 37°C in a chemically defined medium (*3*) in an atmosphere of 5 percent CO_2, 20 percent O_2, 75 percent N_2; 25-hydroxycholecalciferol was added in ethanol; test and control media were adjusted to contain 1 percent ethanol. Each point represents the mean ratio ± S.E. for cumulative ^{45}Ca release from four pairs of cultures.

test whether vitamin D was less effective in vitro because it could not reach the appropriate site or because a transformation in vivo was required, a number of vitamin D preparations were tested in tissue cultures of long bone shafts of the fetal rat in a chemically defined medium (*4*). Resorption was measured as the release of previously incorporated ^{45}Ca from paired test and control bones (*5*). Crystalline vitamin D_3 (Eastman) dissolved in propylene glycol or ethanol, a water-soluble preparation (Vi-De-3 Hydrosol), and a water-dispersible preparation of vitamin D_2 (Mann Assay Laboratories) did not consistently enhance resorption during the first 3 days of culture. The crystalline vitamin D_3 preparations in doses of 300 to 400 units per milliliter caused variable increases in ^{45}Ca release during the 3rd to 6th day of culture; the others were without effect. These slow responses suggested that the effect might be the result of a transformation product of vitamin D. We therefore examined the effects of a physiologically active metabolite of vitamin D_3 found in serum and tissues, including bone (*6*). This material was originally called peak IV on the basis of its elution position on silicic acid chromatography. Purified samples of peak IV isolated from hog serum (*7*) stimulated bone resorption consistently during the first 3 days of culture. The active component of peak IV was then isolated in pure form and identified as 25-hydroxycholecalciferol (*7, 8*). This material had an effect on bone resorption qualitatively comparable to that of purified parathyroid hormone (PTH). Calcium-45 release was significantly increased by doses ranging from 0.9 to 27 units per milliliter (16 to 500 ng per milliliter or 4×10^{-8} to $1.2 \times 10^{-6} M$). The response to 25-hydroxycholecalciferol and purified PTH had the same time course (Fig. 1). The data for the first 2 days of treatment show parallel dose-response slopes for both agents. Low doses of 25-hydroxycholecalciferol and PTH produced significantly greater increases in ^{45}Ca release when added together than when added singly, suggesting a synergistic interaction of the two agents. Rat thyroid calcitonin (TCT) completely inhibited the stimulation of ^{45}Ca release by 25-hydroxycholecalciferol during the first 2 days of culture (Fig. 2). However, there was a subsequent escape from inhibition similar to that observed with PTH (*9*). Measurements of total bone calcium and decalcified dry weight confirmed the data on release of ^{45}Ca and indicated that losses of bone matrix and mineral were parallel during resorption stimulated by 25-hydroxycholecalciferol.

Our data indicate that low doses of an active metabolite of vitamin D_3 stimulate bone resorption in vitro. 25-Hydroxycholecalciferol is 1.4 times more active per unit weight than cholecalciferol in curing rickets in rats and chicks (*10*). It stimulates calcium transport in the intestine and bone resorption in vivo more rapidly than cholecalciferol does (*10*). The much greater effectiveness of the metabolite in tissue culture suggests that bone cannot convert the vitamin to an active form in this system or does so only slowly. With radioactive vitamin D_3, evidence which demonstrates that the liver is the major site of 25-hydroxycholecalciferol production has now been obtained (*11*). It is likely that bone resorption is stimulated in vivo only after vitamin D is transformed to 25-hydroxycholecalciferol and taken up by bone. The effective doses of 25-hydroxycholecalciferol used in our experiments are sufficiently low so that this material could account for stimulation of bone resorption after therapeutic doses of vitamin D in vivo and could explain earlier observations of different effects of serums from animals

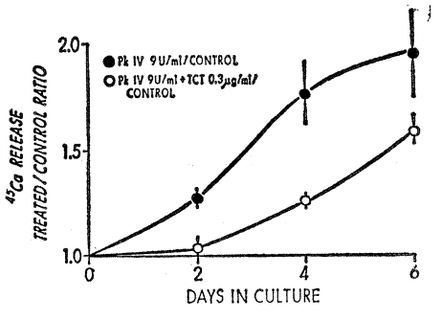

Fig. 2. The effect of purified rat thyroid calcitonin (TCT) on the stimulation of ^{45}Ca release from fetal rat bones by 25-hydroxycholecalciferol (peak IV) in tissue culture. Each point represents the mean ± S.E. for cumulative ^{45}Ca release from four pairs of cultures.

deficient in vitamin D and from animals treated with vitamin D (*2*). As a potent and direct stimulus for bone resorption, 25-hydroxycholecalciferol might provide a more reliable and rapid agent for the treatment of hypocalcemia than the various forms of vitamin D now used.

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