difference is accepted by $M$. The problem of correlation of traits has not been ignored, however. Rather, it has been minimized by working with a small number of traits (*8*) and ensuring that they represent all major parts of the body. Because the $M$ statistic eschews correction for covariance, it facilitates the study of those many species for which few specimens are available in museum collections (*9*).

Responding to Atchley's comment on ratios, we recognize that the use of ratios alters the correlation structure of the data. As our goal was to compare the shapes of organisms, it was essential to remove trait correlations due to variation in body size. The ratio method achieves this. According to the criteria of Anderson and Lydic, our use of ratios is warranted (*10*).

While $M$ may not be a perfect distance metric, it seems more valuable in practice than Mahalanobis $D$ for broad comparative studies of evolution at the organismal level. This impression is reinforced by the observation that $M$ is correlated more highly with rank in the taxonomic hierarchy than is $D$ (*11*). We assume that rank in the hierarchy summarizes judgments made by earlier generations of taxonomists about the degree of anatomical difference between organisms. The weaker correlation of $D$ with taxonomic rank is ascribed to the instability of $D$ values calculated from comparisons involving small numbers of individuals per population.

Although we consider Mahalanobis $D$ to be less useful than the $M$ statistic for our type of research, the Mahalanobis distance between humans and chimpanzees (Table 1) is large compared to that between species of frogs. The conclusion reached by use of the $M$ statistic (*3*) is thus bolstered by the results obtained with the Mahalanobis method.

JOSEPH G. KUNKEL
*Department of Zoology,*
*University of Massachusetts,*
*Amherst 01003*

LORRAINE M. CHERRY
*Department of Biochemistry,*
*University of California, Berkeley 94720*
and *Department of Biology,*
*San Diego State University,*
*San Diego, California 92182*

SUSAN M. CASE
*Museum of Comparative Zoology,*
*Harvard University,*
*Cambridge, Massachusetts 02138*

ALLAN C. WILSON*
*Department of Biochemistry, University of California, Berkeley 94720,* and
*Museum of Comparative Zoology,*
*Harvard University*

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3. L. M. Cherry, S. M. Case, A. C. Wilson, *Science* **200**, 209 (1978).
4. The broad studies of anatomical evolution in which we are engaged require the comparison of extremely dissimilar creatures as well as very similar ones. The Mahalanobis method was designed to compare very similar organisms, such as those from different populations within a species (*2*). We are not convinced that it is justifiable, in theory, to use the Mahalanobis method for estimating the morphological distance between such dissimilar species as humans and chimpanzees (where $D^2 = 552$). Others have expressed similar caution [R. D. Reyment, *Biometrics* **18**, 1 (1962); R. S. Corruccini, *Am. J. Phys. Anthropol.* **40**, 425 (1974)].
5. R. G. D. Steel and J. H. Torrie, *Principles and Procedures of Statistics* (McGraw-Hill, New York, 1960).
6. In the case of humans and chimpanzees, for example, the covariance structures are very different. The differences in $r$ value for pairs of traits range from $-0.68$ to $+0.62$. In contrast, the variances of each trait are similar in the two species (*3*).
7. In defining the $M$ statistic Atchley substitutes "standard error of the difference between the means" for "pooled standard deviation of relative trait length." For the original definition of $M$, see (*3*).
8. We do not recommend the use of more than nine traits in computing $M$ (*3*). More traits will magnify the problem of correlated traits to the point where $M$ values become unreliable estimates of distance.
9. For a majority of species in museum collections, complete specimens of only a few representatives are available (*3*, footnote 8).
10. D. E. Anderson and R. Lydic, *Biobehav. Rev.* **1**, 225 (1977).
11. The high correlation of $M$ with taxonomic rank ($r = 0.88$) was illustrated by Cherry *et al.* (*3*) for a series of frog species. A detailed presentation of the results of empirical tests involving Mahalanobis $D$ ($r = 0.74$) and other metrics is in preparation.
12. We thank R. C. Lewontin for valuable criticism of an earlier draft.

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## Anomalous Water in the Deep Ocean Suggests Lateral Advection-Stirring

Although the report of Amos and Gerard (*1*) is tantalizing, the temperature and density data are incorrectly interpreted. These investigators state that bottom water at 40°26.2′N, 56°55.8′W (station *Lynch* 47-186) in 5200 m of water has the properties of water found about 1000 m higher up in the same water column and suggests turbidity current activity. Their figure 2b (*1*) of near-bottom vertical profiles includes a break in the depth scale to show how the values of salinity $S$, temperature $T$, density $\sigma_t$, and dissolved $O_2$ content at the ocean bottom are also found from 4000 to 4300 m. The problem with this interpretation is that neither $T$ nor $\sigma_t$ are conservative properties in the deep ocean (*2*, chap. 3, p. 1087).

The adiabatic gradient is indicated in their figure 2b for the deepest level; the value shown (0.096°C per kilometer) is, however, incorrect (*2*, p. 63; *3*). In fact, the adiabatic temperature change associated with the downslope advection advocated for the 2.32°C water found at ~ 4200 m amounts to a warming of 0.13°C. A problem associated with using the nonconservative density function $\sigma_t$ in the deep ocean is that profiles of $\sigma_t$ appear unstable. This is also illustrated in their figure 2b; apparently less dense water is found beneath denser water. This artifact of the equation of state of seawater can be circumvented if one uses a conservative density function referenced to a nearby pressure surface; usually the 4000-dbar surface is used as a reference for the density function, $\sigma_4$ (*4*). If potential temperature $\theta$ and a properly refer-

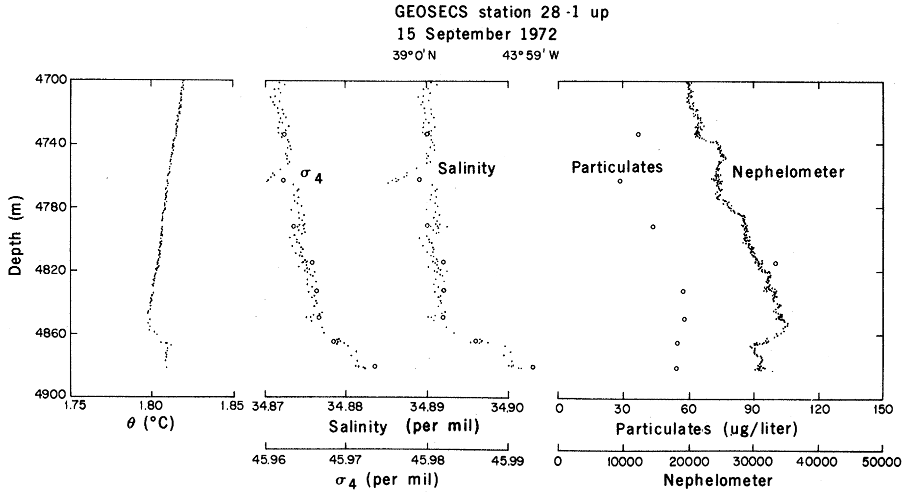

Fig. 1. Profiles of potential temperature $\theta$, salinity $S$, density $\sigma_4$, light-scattering, and particulate matter content at GEOSECS station 28 (*6*).

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enced density function are used, the properties of the bottom water found by Amos and Gerard are not those of the water $\sim$ 1000 m above.

Amos and Gerard also incorrectly state that Geochemical Ocean Sections Study (GEOSECS) station 28 (39°N, 43°59′W) shows a steplike increase in light-scattering near the bottom. The profiles of $\theta$, $S$, $\sigma_4$, and light-scattering at this station are reproduced in Fig. 1. In fact, the bottom layer has a lower level of light-scattering than the water mass immediately above. A turbidity current cannot explain the profiles found at GEOSECS station 28. In contrast, a density current of Denmark Straits Norwegian Sea overflow characteristics is seen intruding beneath water of North Atlantic Deep Water characteristics.

Similar anomalous layers, all at $\theta \sim$ 1.81°C, with Denmark Straits overflow characteristics, have been identified at many stations throughout the western North Atlantic (*5*). The anomalous water found at the bottom at station *Lynch* 47-186 (*1*) and GEOSECS station 28 (*6*) as a density current is also seen as an intrusive feature away from the basin margins in deeper water.

Is it not possible that the high turbidity found by Amos and Gerard is due to resuspension by high mesoscale currents in the area? They found that the current at 1.5 m above bottom averaged 23 cm/sec. Schmitz reports distributions of mean eddy kinetic energy along 55°W (*7*). At 40°30′N, 55°W (2° east of station *Lynch* 47-186), a mean eddy kinetic energy of 80 cm$^2$ sec$^2$ was found at a depth of 4000 m. Velocities as high as 50 cm/sec were recorded (*8*).

Laurence Armi
*Woods Hole Oceanographic Institution,*
*Woods Hole, Massachusetts 02543*

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9. Research supported by the National Science Foundation under grant OCE 76-81190 and by the Office of Naval Research under contract N00014-76-C-0197 NR 083-400. Contribution 4355 from the Woods Hole Oceanographic Institution.

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We acknowledge that Armi's explanation (*1*) of the anomalous conditions is a valid and perhaps less speculative alternative than our own (*2*). We concur with Armi that the nonconservative nature of in situ temperature and density ($\sigma_t$) in the deep ocean make these properties unsuitable for water mass tracing. It was our intention to show that properties at the bottom at station *Lynch* 47-186 (including the dissolved oxygen content) are similar to those at the bottom higher up on the continental slope [figure 2c in (*2*)]; we stated that these properties trend toward those of Denmark Strait water. The use of a potential density profile instead of $\sigma_t$ in our figure 2b would have been preferable, and we did not intend to imply that the water column was unstable. We were in error in quoting the adiabatic gradient as being 0.096°C per kilometer (figure 2b); it should be 0.13°C per kilometer.

In defense of our hypothesis, we would point out that downslope advection does occur in several parts of the world's oceans and obviously did occur at this location during the 1929 earthquake (*3*). Our suggestion that turbidity current activity is responsible for the anomalous conditions at the bottom at station *Lynch* 47-186 is based upon the extraordinary amount of suspended material found there. The amount ($\sim$5000 $\mu$g/liter) exceeds by two orders of magnitude that found at Geochemical Ocean Sections Study (GEOSECS) station 28 [figure 1 in (*1*)] and, to our knowledge, is one of the highest concentrations of suspended material yet found in the deep ocean. We pointed out (*2*) that the addition of such quantities of material will increase the density of the sediment-water suspension by an amount comparable to the density effects contributed by the temperature-salinity changes in the near-bottom water column.

The source that we used for GEOSECS station 28 nephelometer data was figure 2 in (*4*). Compared to Armi's figure 1, Broecker and Bainbridge's data from the same original station profile look considerably different. A drop in light-scattering is shown in figure 2b in (*4*) but, compared to the increase in light-scattering immediately above, this decrease is small. Broecker and Bainbridge may not have presented their data referenced to a zero ordinate on the arbitrary scale of units used by the GEOSECS nephelometer. This would enhance the apparent increase in light-scattering that we refer to.

More recent measurements of near-bottom ocean turbidity were taken as part of the High-Energy Benthic Boundary Layer Experiment (HEBBLE) program in an area of the Nova Scotia continental rise about 500 km west of our reported stations (*5*). Results from two cruises (*6*) in 1979 indicate a very strong bottom nepheloid layer in depths of about 5000 m, with particulate concentrations about twice the values reported in (*2*). These high concentrations are associated with strong but variable bottom contour currents.

Anthony F. Amos
*Port Aransas Marine Laboratory,*
*University of Texas Marine Science*
*Institute, Port Aransas 78373*
Robert D. Gerard
*Lamont-Doherty Geological*
*Observatory, Columbia University,*
*Palisades, New York 10964*

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31 March 1980

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## Large Doses of Ecdysterone May Inhibit Mosquito Behavior Nonspecifically

Beach (*1*) has reported that biting behavior in the unfed mosquito *Anopheles freeborni* is inhibited by the injection of ecdysterone, an insect hormone that is produced by the ovaries during oogenesis (*2*). This suggested role of ecdysterone as a behavioral inhibitor warrants a closer examination.

Central to Beach's hypothesis is the report (*2*) that in *Aedes aegypti*, ecdysteroids reach a peak of approximately 275 pg per female at 18 hours after a blood meal. By 30 hours after a blood meal the concentration returns to its low pre-blood meal level. Since this assay was performed on whole body extracts, it is not known how much, or indeed if any, hormone occurs outside the ovary. In *Ae. aegypti*, there is no humoral inhibition of either biting or host-seeking when ecdysteroid concentrations have peaked; the first indications of host-seeking inhibition are at 30 hours after a blood meal, with the greatest inhibition occurring be-