vent extraction, and coprecipitation (*3*). None of these techniques has resulted in convenient and complete isolation of the organic material from sea water.

Tatsumoto *et al.* investigated amino acids in surface waters by an iron coprecipitation method (*4*). In our work, we extended a similar study to deep-sea waters to a depth of 3500 m.

During July 1960, at latitude 25° 45′N, longitude 94°10′W, near the center of the Gulf of Mexico, aboard the research vessel *Hidalgo,* we collected six 200-liter samples from depths of between 10 and 3500 m with Fiberglas and polyethylene water samplers. The water was immediately filtered through Millipore HA filters, and 3 g of mercuric chloride were added to each sample. The dissolved organic material was coprecipitated with ferric hydroxide which was made from 2*N* sodium hydroxide and 2*M* ferric chloride solutions. The precipitates had a *p*H of 9.0 to 9.7, as measured during the return to a shore laboratory, where they were then refrigerated.

At the shore laboratory, the iron precipitates, which contained organic material, were centrifuged to remove most of the remaining sea water, and were then dissolved in hydrochloric acid. Further desalting was accomplished by passing this solution through columns of Dowex-50 cation-exchange resin and Amberlite IRA-400 anion-exchange resin (*5*). Acid hydrolysis in 6*N* hydrochloric acid followed, and the amino acids in the salt-free concentrates were resolved by Amberlite CG-120 ion-exchange resin chromatography (*6*).

Table 1. Distribution of amino acids obtainable by iron coprecipitation in order of abundance: +++ high, > 1 mg/m^3; ++ medium, 1 to 0.5 mg/m^3; + low, <0.5 mg/m^3.

Distribution at depths indicated					
10 m	500 m	900 m	1500 m	3000 m	3500 m
Glutamic acid					
+++	+++	+++	+++	+++	+++
Lysine					
+++	+++	+++	+++	+++	+++
Glycine					
+++	+++	+++	+++	++	+++
Aspartic acid					
++	+++	+++	+++	++	+++
Serine					
++	+++	+++	++	+	++
Alanine					
++	++	++	++	++	++
Leucine					
++	++	++	++	++	++
* *Valine plus cystine*					
++	++	++	++	+	++
Isoleucine					
++	++	+	++	+	+
Ornithine					
+	++	+	+	+	+
Methionine sulfoxide					
+	+	+	+	+	+
Threonine					
+	+	+	+	+	+
Tyrosine and phenylalanine					
+	+	+	+	+	+
Histidine					
+	+	+	+	+	+
Arginine					
+	+	+	+	+	+
Proline					
+		+	+	+	+
Methionine					
+	+		+	+	+

* The peaks corresponding to these amino acids were poorly resolved on the ion-exchange chromatograms.

Table 1 shows that identifiable amino acids were rather uniformly distributed throughout the wide range of depths sampled. Amino acid concentrations in the acid hydrolyzate were about three times greater than in an unhydrolyzed portion of an identical sample which had been taken at 3000 m. However, unidentifiable ninhydrin-positive resolution peaks in the unhydrolyzed sample indicated the existence of substances similar to peptides in deep-sea water.

Although the analyses were not strictly quantitative (*7*), our findings indicate that there are substantial amounts of amino acids in deep-sea water (*8*). Along with other dissolved organic material, these may eventually be adsorbed on and incorporated in the deep-sea sediments or used by deep-sea microorganisms (*9*).

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5. Detailed laboratory procedure on the isolation of amino acids from sea water is given in a Ph.D. thesis by Kilho Park, Texas A. & M. College, 1961.
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7. Measurements by carbon-14 tracer techniques indicated that the percentage yield of free amino acids by the iron coprecipitation method ranges from a minimum of 30 percent for alanine to a maximum of 85 percent for lysine. A study of the recovery of peptides and proteins is current at Texas A. & M. College. Preliminary results indicate nearly quantitative yields. The data in Table 1 are not corrected for any losses during fractionation.
8. Although virtually all kinds of organic matter in the sea can be mineralized by marine bacteria [see C. E. ZoBell, *Marine Microbiology* (Chronica Botanica, Waltham, Mass., 1946)], dissolved organic matter is continuously replenished by marine life. A list of various dissolved organic substances found in sea water has been compiled by E. K. Duursma [*Neitherlands J. Sea Res.* **1**, 1 (1960)].
9. This work was supported by grants A-003 and A-022 from the Robert A. Welch Foundation, Houston, Texas. The assistance of Mrs. A. F. Isbell is appreciated.
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Water Relations of Plant Communities as a Management Factor for Western Watersheds

Abstract. Altering natural succession may become a major way of modifying plant cover thereby increasing water yield.

Scarcity of water for human use has influenced the history of mankind profoundly (*1*) and is currently a source of national concern. Much research effort has been focused recently on watersheds as our primary source of water (*2*).

Yield from many watersheds may be considered simply as the excess of precipitation over direct evapotranspirational loss from soil and plants. Hoover (*2*) indicated that, although altering plant cover to reduce this evapotranspirational loss is probably the major practical means of increasing yield from most watersheds, very little information is available as a basis for the practice. He summarized as follows: "The real need is to spell out what kind, size, age, and arrangement of plant cover is most effective for specific situations. This is the sort of information that land managers can use."

The current need is slightly different for Western watersheds, for these are mostly extensive wildlands on remote mountain slopes where intensive manipulation to maintain ideal cover is still impractical. Here a watershed manager can probably aspire to little more than altering the speed or direction of natural succession (the gradual replacement of one species by another). His basic decision will probably involve only desirable trends of vegetational change rather than the most effective

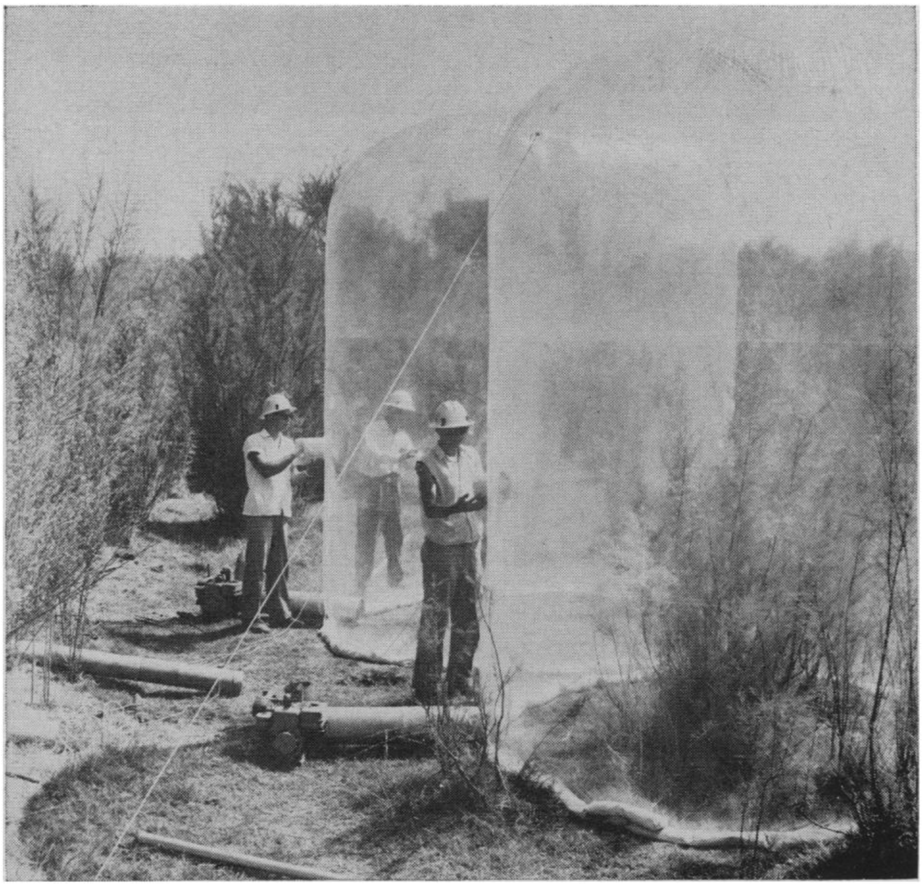

Fig. 1. Plots enclosed in inflated tents of transparent plastic film for direct measurement of evapotranspiration in the field.

end conditions. Ideally, that decision would be based on the annual evapotranspirational loss of the whole watershed with its existing cover as compared with the loss with an altered cover. To try to make such measurements directly is obviously impractical, but useful estimates can be made from values for evapotranspiration of representative plots of the two cover types.

A technique was developed recently for direct measurement of evapotranspiration of undisturbed plots in the field (*3*). A plot is enclosed in an inflated tent of transparent plastic film (Fig. 1), and the amount of water vapor it produces is computed from measurements of humidity and ventilation (*4*). Values derived with this technique for diverse kinds of plant cover can be extended, by standard sampling procedures, to provide estimates of relative annual evapotranspiration for a watershed and can thus be the basis for a decision as to whether one cover type should be encouraged at the expense of another on a specific site in order to reduce the rate of loss (*5*). Enclosure of a plot for purposes of measurement can ordinarily be expected to reduce the evapotranspiration rate somewhat, but such an effect does not interfere with the usefulness of the technique for the primary objective. If rates for unenclosed plots are needed, for some other use, empirical corrections can be made (*3*).

If future watershed practices are to include controlled alteration of natural succession, much more basic explanatory ecological information than we have now is needed. This lack is called to the special attention of advisers to graduate students in plant ecology and silvics. Nearly every specific successional sequence poses an untouched problem worthy of a graduate thesis. As Oosting (*6*) has noted: "Actually, specific knowledge of successional causes is limited and sometimes difficult to obtain. The subject offers areas of profitable investigation that will not be exhausted for some time to come." Moisture probably becomes an important factor in many sequences by causing failure of individual plants. Such failures are probably traceable, in turn, to internal moisture deficits, for, as Kramer has pointed out (*7*), plant behavior is more closely related to internal moisture deficit than to any other commonly measured moisture parameter.

Because successional events are extremely complex within the range of direct observation (an explanation may include sequential consideration of community events, plant events, organ events, tissue events, cellular events, and so on), and because their time span is great with respect to that of the observer, unusually careful planning and analysis are required for productive research. Simple intuitive logic that is adequate for most research on the biochemical or biophysical aspects of plant physiology may be misleading in explanatory ecology. A formal system of logic has been designed especially for the complex problems of explanatory ecology, and its usefulness in detecting fallacies in several apparently valid lines of reasoning—fallacies that have caused some ecological studies to go astray—has been demonstrated (*8*).

These physical, conceptual, and logical tools may help to solve some of the many problems involving the water relations of plants which still face managers of Western watersheds (*9*).

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4. The apparatus has been simplified recently by substituting ordinary psychrometers for the original infrared hygrometer. It is now entirely portable and has been used routinely in the field by three inexperienced crews after about 5 days of training.
5. It should be emphasized, however, that maximizing water yield is just one of several important considerations affecting a management decision to alter vegetation.
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9. This report is based on a talk presented 28 August 1961 at Purdue University in a symposium on weather and organisms.

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