THDOC and a metabolite of the sex steroid, progesterone, act like barbiturates. Surprisingly, the two steroid metabolites are even more potent than pentobarbital in enhancing the inhibitory effects of GABA.

"This is speculation," says Barker, "but if cortisol can be converted to an active metabolite, and if the metabolite crosses the blood-brain barrier and enters the cerebrospinal fluid and the brain, then the metabolite might be expected to amplify the inhibitory effects of GABA. If these events take place, they might help to explain why the central nervous system is depressed when there are abnormally high levels of cortisol in the blood."

Majewska points out that when steroid levels are high in the bloodstream, they will also be high in the cerebrospinal fluid (CSF) that bathes the brain. "The brain is like a sponge for steroids," she says. Steroids are very soluble in cell membranes and would be expected to cross the blood-brain barrier and enter the CSF.

According to Gold, "There may be other ways in which GABA and adrenal steroid hormones interact." For instance, GABA may inhibit cortisol production by blocking CRH release from the hypothalamus. And in addition to their direct actions on surface membrane receptors for GABA, the steroid hormones may enhance the inhibitory effects of GABA indirectly, by acting through intramembrane enzymes.

Gold thinks one problem in depressed patients is an abnormally high level of CRH produced by the hypothalamus, a condition that may result from too little GABA inhibition of CRH production.

"The clinical observation of the effects of glucocorticoids on mood are very complex," says Gold. "These steroids may produce euphoria in short-term low doses and depression in long-term high doses."

Majewska proposes that many of the mood changes associated with stress, the menstrual cycle, and pregnancy may be related to the effects that steroids and their metabolites have on nerve cells in the brain. And with depression, Cushing's disease or anorexia nervosa, when blood steroid levels increase, mood changes such as anxiety and depression may be even more pronounced.

■ DEBORAH M. BARNES

ADDITIONAL READING

M. D. Majewska *et al.*, "Steroid hormone metabolites are barbiturate-like modulators of the GABA receptor," *Science* **232**, 1004 (1986).
P. W. Gold *et al.*, "Responses to corticotropin-releasing hormone in the hypercortisolism of depression and Cushing's disease," *N. Eng. J. Med.* **314**, 1329 (1986).
P. W. Gold *et al.*, "Abnormal hypothalamic-pituitary-adrenal function in anorexia nervosa: Pathophysiologic mechanisms in underweight and weight-corrected patients," *ibid.*, p. 1335.

Briefing:

The Ocean's Deserts Are Blooming

Oceanographers are increasingly confident that they have been underestimating the biological productivity of almost half of the world's ocean. On a recent research cruise to the central North Pacific, supposedly one of the least productive regions of the world's ocean, they found two to three times as much organic matter being created through photosynthesis as had been reported in the past. Although part of the problem may have been with the traditional carbon-14 method of productivity measurement, oceanographers strongly suspect that they have not sampled the ocean often enough to catch the pulses of high productivity that may account for much of the total production in such waters.

The North Pacific cruise last August and September was part of a project on the study of plankton rate processes in oligotrophic (least productive) oceans. On the cruise, independent groups measured productivity using three different techniques, all of which depended on measuring changes in a few hundred milliliters of water collected in bottles. One technique is the traditional carbon-14 method in which photosynthesis incorporates carbon-14–labeled carbonate in new organic matter. A second technique involves the labeling of the water with oxygen-18, which shows up in the oxygen produced by photosynthesis. The third technique is a conventional titration of the resulting oxygen that is precisely controlled by a computer.

The results of the three methods agreed well with each other, according to project coordinator Richard Eppley of Scripps Institution of Oceanography, and recorded primary productivity at the rate of 550 milligrams of carbon per square meter per day, which is two to three times the value previously reported for the study area about 640 kilometers north of Hawaii. In fact, the rates are similar to those found on the project's 1982 cruise much nearer Hawaii. In that case, the relatively high productivity had been attributed to the proximity of the islands.

Eppley says that the group cannot explain the higher productivity, but the ultraclean approach applied to all three methods may have played a role. George Knauer of the University of Southern Mississippi had recommended that water sampling and handling equipment be as clean as possible to avoid poisoning the phytoplankton, especially with toxic trace metals. Time limitations prevented a complete comparison of traditional and ultraclean conditions, but the project workers agree that they now have more confidence in the data when ultraclean methods are used. They also agree that results might be even more reliable if bottles could be avoided entirely. Despite the care they took, microscopic inspection revealed phytoplankton dying during the incubation of the water samples, presumably because a bottle is not as hospitable as the ocean.

An alternative to small bottles has been huge, ocean-scale volumes of seawater bottled up by natural ocean processes. In the latest such experiment, William Jenkins and Joel Goldman of the Woods Hole Oceanographic Institution used published data from 18 years of observations near Bermuda in the Sargasso Sea. They measured productivity by following the photosynthetically produced oxygen temporarily trapped during the summer within the warm, stable upper 100 meters. They found a rate of 50 grams of carbon per square meter per year, a rate so high that the amount of nitrate nutrient in the water could not possibly fuel it.

Jenkins and Goldman suggest that the needed nitrate mixes upward from deeper waters only now and then, possibly during stirring by storms, to create a localized pulse of high productivity. This hypothesis would make it less likely that oceanographers' relatively skimpy sampling would produce representative results. Nutrient supply from below would also tend to create two layers of differing productivity, Jenkins and Goldman point out. The upper layer would be the traditional low-nutrient, biological desert where perhaps 90% of what little organic matter is produced would be destroyed and its nutrients recycled to fuel further production.

In the lower layer, just above the source of nutrients, nutrient supply would be higher and thus production could be higher, but recycling would be less efficient, allowing perhaps 50% of the organic matter produced to escape by falling into deep water. Knauer and his colleagues in the Vertical Transport and Exchange (VERTEX) research program have found evidence of such a two-layer structure in the oligotrophic North Pacific. Trevor Platt and William Harrison of the Bedford Institute of Oceanography have argued recently that, overall, recycling under the conditions proposed for a two-layer system would be less efficient than previously assumed. That could help explain the difference between bottle methods and large-scale methods, a comparison of which requires some estimate of recycling efficiency. ■ RICHARD A. KERR