wavelength thermal radiation from the warm sand and warm mass of air above the desert surface. With the sun's rays traversing 5 air masses, the available energy is reduced to about half of its noontime maximum but the percentage passing through to the abdomen has risen to 20 percent while the amount absorbed by the elytra has decreased to 73.6 percent.

The thermal strategy of maximum surface absorptance in visible wavelengths and selectively elevated transmittances in NIR wavelengths is an alternative to the thermal strategy of color change as shown by the desert iguana (*Dipsosaurus dorsalis*) (*8*). This pattern is one of several adaptations of these beetles enhancing thermoregulatory efficiency. Behavioral thermoregulatory actions contribute quantitatively greater absolute value to the maintenance of thermal equilibria, but the combination of physical and behavioral adaptations establishes the potential for thermal optimization. The adaptive nature of NIR transmittance in *O. plana* could be an accident of the beetle's elytral morphology or the result of positive selection. However, when considered in terms of the solar radiation regime to which these arthropods are exposed, the differential transmittance shown in the NIR seems to be the least costly alternative for the utilization of the given environmental regime to produce maximum sublethal body temperatures for the greatest period of time each day.

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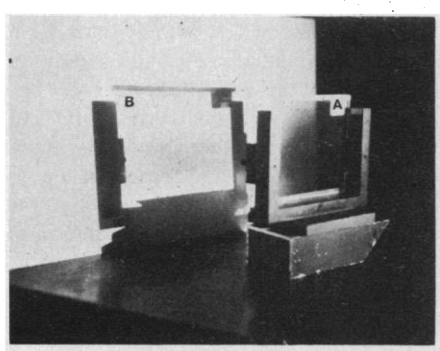
Optical Holographic Three-Dimensional Ultrasonography

Abstract. *Three-dimensional ultrasonograms prepared by superposition optical holography improves anatomical orientation and reduces the volume of data needed to study parenchymal organs such as breast, liver, kidney, spleen, and others. An optical hologram makes it possible to simultaneously view multiple planes of observations and see through and around structures without the superimposition of overlying structures. The use of pulse echo ultrasonograms results in better resolution and gray scale and permits multiplane viewing and eliminates the geometric distortions present in acoustical holography.*

Ultrasonography, a painless, apparently harmless, noninvasive modality, enables physicians to observe structural features that were previously only visible upon surgical exploration. One of the impediments to broader application of this technique is that B-mode pulse echo ultrasonographic systems produce planigrams of the examined tissue. An ultrasonographic planigram is a scan of tissue about 0.5 mm thick. The tissue above and below the level of the acoustic scan (planigram) is therefore invisible. To adequately visualize a three-dimensional organ, it is necessary to serially scan the organ at an arbitrary interval. Thus, to detect lesions as small as 0.5 cm in size, serial scanning at 3-mm intervals must be performed. Such scanning of organs, for example, the breast, liver, and spleen, result in the accumulation of a vast amount of data which must be studied in detail to arrive at a diagnosis.

This volume of data may be effectively reduced by forming a three-dimensional ultrasonogram from the individual serial ultrasonograms by optical holographic techniques.

As in all optical holograms, there is no superimposition of structures, so that it is possible to observe structures from different viewing angles as they are oriented in vivo. In addition, the optical hologram absorbs so little light that it remains transparent even at high information densities. Figure 1 is an optical holographic reconstruction of 2.1 cm of breast tissue which demonstrates the minimal absorption of such a hologram. Prior three-dimensional



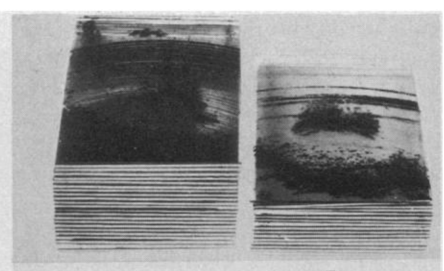
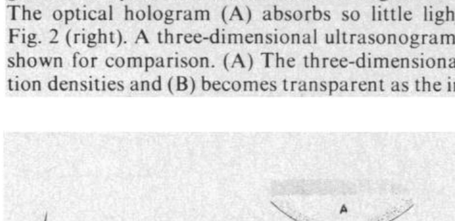


Fig. 1 (left). An optical hologram of a three-dimensional ultrasonogram. This optical hologram is composed of six ultrasound tomograms. This represents a 2.1-cm-thick slab of breast tissue. The optical hologram (A) absorbs so little light that it produces only minimal shadowing (B). Fig. 2 (right). A three-dimensional ultrasonogram of an eye prepared by the glass plate technique is shown for comparison. (A) The three-dimensional ultrasonogram is light-opaque at high information densities and (B) becomes transparent as the information densities decreased.



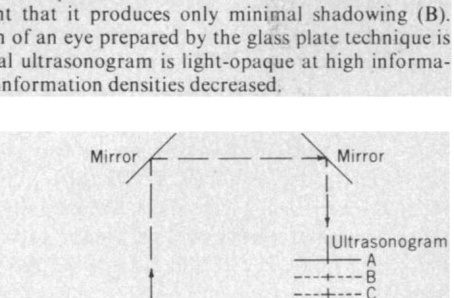


Fig. 3 (left). A diagrammatic representation of the appearance of an ultrasound mammogram through different levels of scan. (A) Ultrasonogram representing a section taken above the nipple. (B) A section through the nipple. (C) a section below the nipple. In practice, serial scans are taken at 3-mm intervals to detect lesions 0.5 cm in size. Fig. 4 (right). Formation of a superimposition optical hologram of serially scanned ultrasonograms.

ultrasonograms made by glass plate (*1*) or digital technique became light-opaque at high information densities (*2*) (Fig. 2).

Although acoustic holographic systems in theory produce a three-dimensional image, in practice it is possible to observe only a single plane at a time in the focal zone. In addition, the quality of the image produced by acoustic holography is poorer than that produced by pulse echo systems. The higher acoustic energies used by these instruments is also undesirable (*3*).

For these reasons, optical holographic reconstruction of pulse echo ultrasonograms was chosen over acoustic holography for three-dimensional ultrasonography.

Ultrasound mammography is carried out by serially sectioning the breast in a vertical direction at 3-mm intervals (Fig. 3). Figure 4 illustrates the preparation of an optical hologram of the three-dimensional ultrasonogram. Ultrasonogram A is placed in position A on Fig. 4, and the film is placed at plane A′. An optical hologram of ultrasonogram A is taken. Ultrasonogram B is now placed in position B and the same film is moved to plane B′. A second optical hologram of ultrasonogram B is recorded on the same film, thus producing a superimposition optical hologram of Fig. 4, A and B. In a similar fashion, ultrasonogram C is placed in position C and the same film is moved to plane C′. By this method the superimposition hologram shown in Fig. 5 has been prepared (*4*).

When the resulting optical hologram is viewed with a laser light beam, a three-dimensional image of the organ is observed. Figure 5 illustrates the ability of the optical hologram to cause a cyst to stand out, with simultaneous display of the fine breast structure. Since this is a flat photograph, the observer loses the three-dimensional effect which is present when the hologram is viewed under laser light. Further improvements in the ultrasonic images may also be obtained by optical deblurring and data processing of ultrasound mammograms prior to the formation of an optical hologram.

The methods outlined are applicable to the study of all organs that can be serially scanned and represent a unique way of studying organs in three dimensions. For ultrasound mammography in particular, it holds the promise of improved detection, localization, and differential diagnosis because this mode of display facilitates interpretation by making it possible to trace the course of ducts, blood vessels, fascial planes, and muscles.

In summary, optical holographic reconstruction has been used to form three-dimensional ultrasonograms. This technique has been applied to ultrasound mammography. Its use reduces the volume of ultrasonic data and permits the visualization of organ structure in three dimensions without superimposition and shadowing. This major advance in ultrasonic imagery may make practical the application of pulse echo techniques for cancer detection surveys.

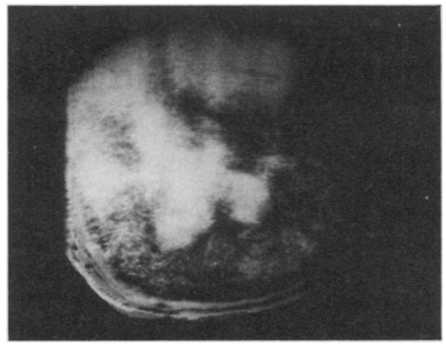


Fig. 5. The internal structure of the breast is visualized in three dimensions when the optical hologram is viewed in laser light. The optical hologram causes the cyst within this breast to stand out. The fine structures of the breast are simultaneously displayed.

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Biological Uptake of Dissolved Silica in the Amazon River Estuary

Abstract. *Approximately 25 percent of the dissolved silica carried by the Amazon River is depleted through diatom production in the inner estuary. Annual production of opaline frustules is estimated to be 15 million tons. However, few diatoms accumulate in modern shelf sediments and chemical recycling appears to be slight. Instead, many frustules apparently are transported landward into the river system, where they deposit in dunes and layers on and within mud and sand bars.*

Rivers contain approximately two orders of magnitude more dissolved silica than does surface ocean water. The fact that this transition from silica-rich to silica-poor water often takes place abruptly in coastal estuaries is most easily explained by conservative dilution of river effluent by ocean water (*1–3*). Uptake of silica by clay minerals may be important in the global chemical budget (*4*), but evidence for chemical removal in estuaries is lacking (*5*). Biological uptake of silica has not been confirmed in any major estuary (*6*), although opaline diatoms often are common in estuarine waters. For instance, diatom populations in the brackish surface waters off the Amazon River exceed 1 to 4 mg/liter (*7*), a sufficiently large quantity to affect the silica concentration. The significance of this process can be appreciated when one considers that the Amazon contributes approximately 40 percent of the dissolved silica brought into the Atlantic Ocean (*8*).

During a recent cruise of the R.V. *Chain* (10 to 18 June 1974) we studied further the possible interactions between diatom production and uptake of dissolved silica in the Amazon estuary. Samples for salinity, suspended matter, dissolved silica, and other chemical parameters were taken at closely spaced intervals while the ship was carrying out geophysical studies in the area; additional samples were collected at four hydrographic stations and from the tops of two gravity cores. In total, more than 120 suspended matter and 60 silica samples were taken (Fig. 1) and analyzed (*9*).

The Amazonian rainy season (February through June) was unusually wet in 1974, and during the period of observation winds were unusually low (often less than 3 m/sec). As a result, the Amazon River effluent (defined by the 10 per mil isohaline) extended more than 200 km offshore (Fig. 1). Because of the lack of mixing, however, the freshwater lens was very thin, and on the inner shelf near-bottom salinities (at 5 to 7 m) ranged from 14 to 19 per mil.

Surface waters near the mouth of the river contained more than 140 mg of suspended matter per liter, mostly terrigenous