It is also unlikely that this abnormality resulted from long-standing insulin deficiency, since it was demonstrable as early as 2 weeks after the acute onset of diabetes in a 16-year-old subject.

In conclusion, plasma glucagon in the juvenile-type diabetic neither rises during hypoglycemia nor falls with hyperglycemia. Thus the diabetic pancreatic alpha cell appears to be insensitive to changes in the concentration of plasma glucose. Since there are data indicating diminished sensitivity to glucose for the diabetic beta cell (*14*), an intrinsic functional defect common to both alpha and beta pancreatic cells may be operative in juvenile diabetes mellitus. The site of such a lesion is speculative but may involve either loss of glucose recognition because of a defective glucose receptor or aberrant transmission of a perceived glucose signal due to a defective intracellular messenger system. The fact that glucagon responses to arginine still occur in diabetes would seem to exclude a common defect in the secretory apparatus. Current models for islet cell secretion which emphasize the role of a glucose receptor (*15*) and of Ca^{2+} (*16*) and cyclic adenosine monophosphate (*15*) as intracellular messengers are compatible with these possibilities.

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Sphaeroma terebrans: A Threat to the Mangroves of Southwestern Florida

Abstract. Sphaeroma terebrans, *a wood-boring isopod, is destroying the prop roots of red mangroves along the southwestern coast of Florida to such an extent that the Ten Thousand Islands and mangrove fringes of the mainland are steadily shrinking. Mangroves of the Florida Keys apparently are free of this wood borer.*

For an undetermined number of years, a wood-boring crustacean of the order Isopoda, *Sphaeroma terebrans* Bate (*S. destructor* Richardson), has been destroying the prop roots of the red mangroves, *Rhizophora mangle* L., along the southwestern coast of Florida (*1*). The attack of *Sphaeroma* is centered in the Ten Thousand Islands region in the midst of the greatest stand of mangroves in North America and one of the greatest in the world. The result is that the shoreline of the mainland and of the mangrove islands is gradually shrinking. An ecocatastrophe of serious magnitude to the seaward fringe of the Everglades National Park and adjacent areas appears to be in progress. *Sphaeroma* has already eliminated much of the protective outer edge of this great mangrove stand. It threatens to eliminate much more and to alter those features of the Everglades environment that depend upon the red mangrove barrier.

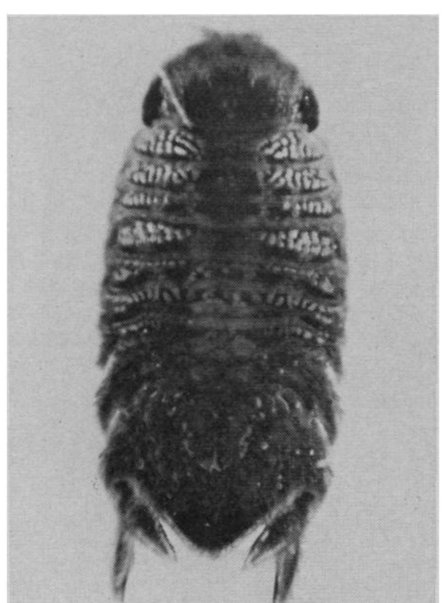

Fig. 1. A 10-mm adult specimen of *Sphaeroma terebrans* from a burrow in a red mangrove prop root. [Photograph by N. J. Eiseman]

About 70 years ago Richardson (*2*) reported that *Sphaeroma terebrans* (Fig. 1) had been observed boring into pier pilings at the mouth of the St. Johns River near Jacksonville. Apparently the only reported occurrence of this species on the Gulf coast of Florida (*3*) involved its capture in a plankton net.

In connection with a study of the benthic algal epiphytes of red mangrove prop roots throughout southern Florida, we discovered that a major portion of the trees in the Ten Thousand Islands area had their prop roots cut off at approximately the level of mean high water so that their normal benthic algal epiphytes were not present. Those prop roots that remained were perforated on their shaded (concave) side and exhibited all stages of destruction accompanied by secondary decomposition by bacteria and fungi. Inside these prop roots were numerous individuals, both juveniles and adults, of *Sphaeroma.*

We were able to demonstrate that this isopod is a rapid borer into living mangroves by placing pieces of uninfected prop roots and seedlings 20 to 30 cm long in a container of seawater with a few adult *Sphaeroma.* The isopods bored into the mangrove material within 24 hours and produced extensive hollowing within a few days.

Depredations of *Sphaeroma* are extensive in northern Florida Bay and in Whitewater Bay in the Cape Sable area, and are extremely severe among the Ten Thousand Islands north to Naples (Fig. 2). The isopod has infested red

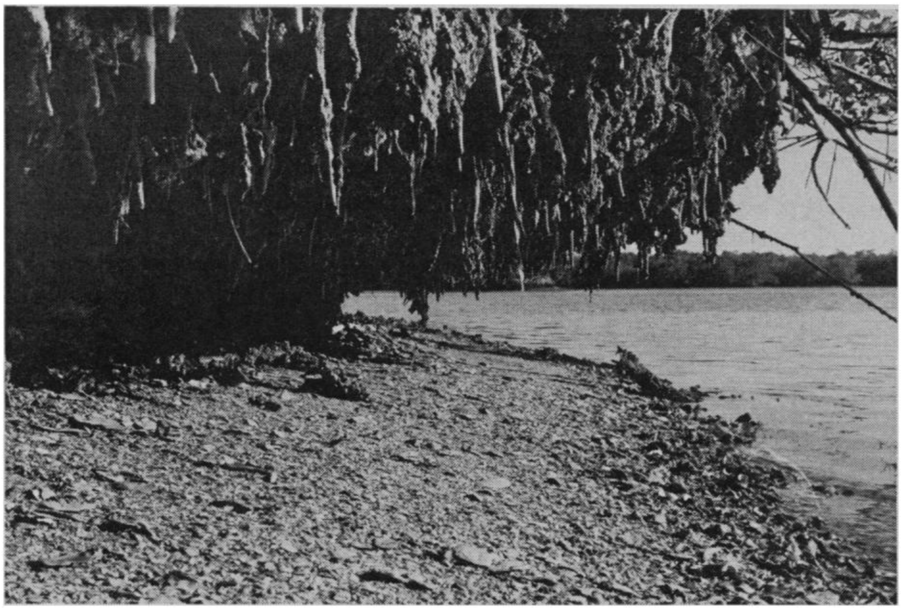

Fig. 2. After the prop roots have been destroyed, the undercutting of the peat deposit upon which mangroves grow is rapid and continual. This photograph shows a section of mangroves at the fringe of the stand near Everglades City, Florida, that will probably topple into the water during a storm in the near future.

mangroves along the Florida Gulf coast northward at least to Anclote Keys near Tarpon Springs, and probably as far north as red mangroves occur. The Florida Keys from Key Largo to Key West, however, appear to be free of *Sphaeroma*, and the normal outward expansion and land-building activities of red mangroves around these islands are continuing.

Sphaeroma enters the prop roots of red mangroves principally on the concave side (Fig. 3). Apparently new invasions are usually the work of adults (nearly all entrance holes observed were about 5 mm in diameter). Reproduction occurs inside the roots (in the laboratory within 2 to 4 weeks at about 25°C); the young pass through all developmental stages within the root and soon join the adults in wood boring. In highly infested areas, all prop roots of the outer fringe of mangroves have been destroyed up to the maximum intertidal level at which the isopod can work, and the trees are standing on their poorly developed main axes or oldest prop roots. When the activity of *Sphaeroma* has reached this stage, as it has from Naples to Cape Sable and throughout the Ten Thousand Islands, wave and current action erodes and undercuts the exposed and unprotected substrata, principally 170 to 450 cm of peat (*4, 5*). Summer squalls and hurricanes then cause individual trees or groups of trees at the margin to topple into the water, deepened by erosion, and the process begins anew (Fig. 2).

Fig. 3. This red mangrove root has been hollowed out by *Sphaeroma*, but the lower portion has not yet broken off. Numerous entry holes of adult isopods are visible in the part of the root that was below mean high tide and are most numerous on the concave (shaded) side.

That this shrinkage of the mangrove stands along the southwestern coast of Florida has been going on for some time, especially since 1950, is evident in the literature. Spachman *et al.* (*5*) have pointed out that an aerial photograph of Whitewater Bay near Cape Sable taken in 1953 shows an isthmus and several islands that were no longer present in 1964. "No evidence has been found indicating that the area occupied by the islands is increasing. Instead, the opposite appears to be occurring. . . . A cruise through Whitewater Bay will reveal islands in all stages of destruction." This is quite in contrast to the prediction of Harshberger in 1914 (*6*) that Whitewater Bay would be filled in as a result of the growth of the mangrove islands. The condition of the mangroves is also at variance with the calculation of Davis (*4*) that about 600 ha of new mangrove swamps appeared in northern Florida Bay east of Cape Sable and along the Florida Bay side of the Keys during the first three or four decades of the present century, and with his prediction in 1940 that the present Ten Thousand Islands may coalesce in the future.

Good evidence that *Sphaeroma* was at work at the time that Davis was investigating the mangroves of southern Florida (*4*) is to be found in his paper: "The holes found through the stilt-roots of *Rhizophora* are credited by some persons to this animal (*Teredo*), but none were found in the holes; instead an unidentified burrowing crustacean was nearly always found, and may have caused the damage." It seems unlikely that the activities of *Sphaeroma* at that time approached the present-day rate of destruction.

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