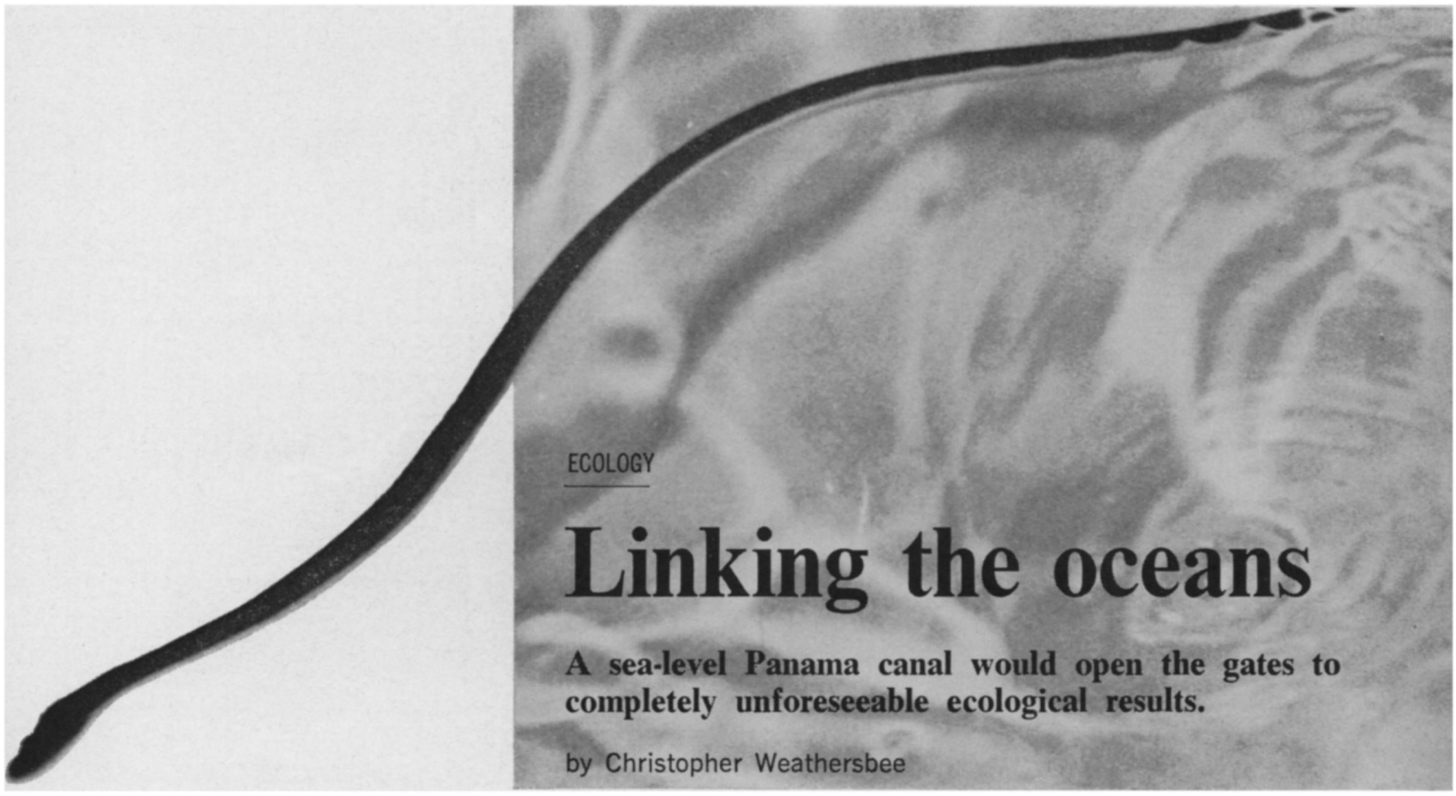


ECOLOGY

Linking the oceans

A sea-level Panama canal would open the gates to completely unforeseeable ecological results.

by Christopher Weathersbee

Smithsonian

If one lesson should have been learned in man's history-long attempt to reshape his environment, it is that biological rearranging is best left to natural forces.

Thus there is a host of examples such as the invasion in the 1930's of the Great Lakes by sea lampreys via the Welland Canal and the consequent destruction of an important fishery. There are very few examples of benefits arising out of transplantation of life forms.

Ecologists are raising the possibility of another Welland Canal disaster, involving not one alien species in a lake but hundreds in an ocean. The canal in question is the proposed sea level Panama canal.

It might be supposed that before final plans for such an impressive engineering feat are approved, every aspect will have been studied. And the Interoceanic Canal Study Commission, facing a 1971 deadline on canal construction recommendation, has in fact ordered biological studies from the Battelle Institute of Columbus, Ohio.

But these are confined almost entirely to the ways in which radioactive debris from possible nuclear excavation could affect man.

There is apparently very little official interest in the fate of organisms which are uninvolved with man but which might be affected in unforeseeable ways by the rejoining of the Atlantic with the Pacific.

Halfway around the world, the Suez Canal is one man-made link between oceans and their diverse ecosystems which should be a warning to the canal planners. Developments there are beginning to demonstrate the kind of phenomena that might be expected in Panama. Over the last 100 years dozens of Red Sea organisms have migrated through the canal into the Mediterranean. Some marine biologists think they may eventually replace most of the native life forms (SN: 3/30, p. 312).

Any trouble that a new Panama canal might brew would not wait 100 years and would come, ecologists believe, in bigger doses. The Suez Canal has a natural barrier to biota mixing, the Bitter Lakes. Situated midway along the canal, these lakes have such high salinity that few organisms can cross them.

The existing Panama Canal has an analogue of the Bitter Lakes; the water in Gatun Lake is too fresh to allow most marine organisms to pass.

A sea-level canal across the isthmus, on the other hand, would lack any such check. Whole schools of fish could make the transit. There even would be, for some of them, a helping current flowing from Pacific to Atlantic.

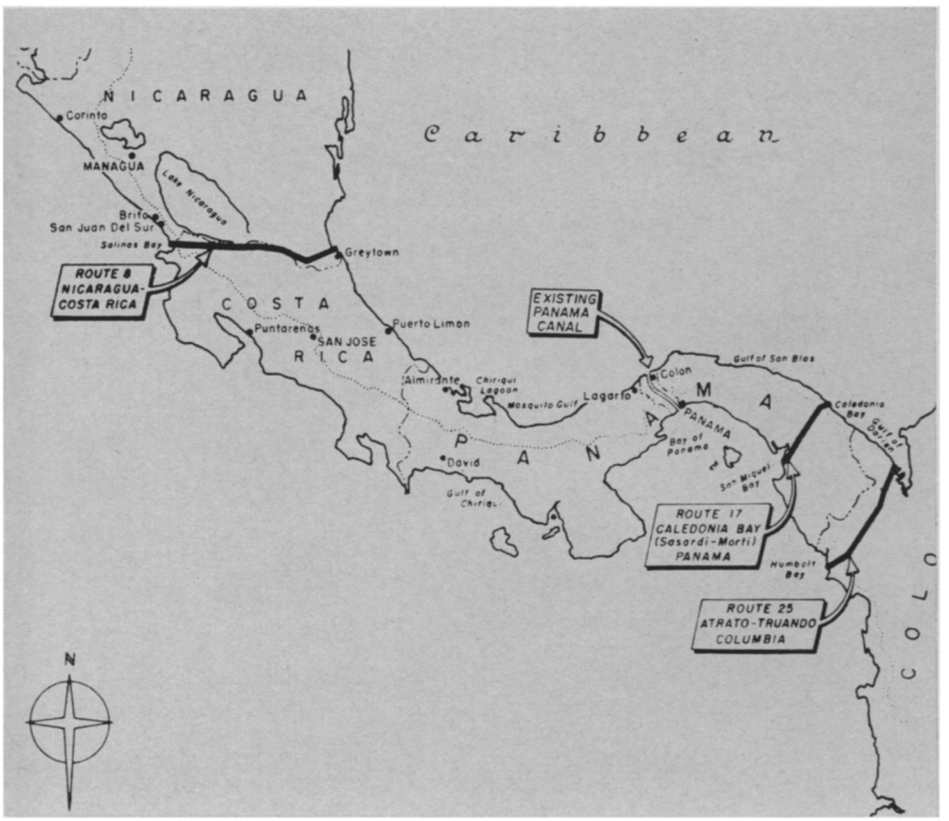
Much of the ecological history of the area hinges on the time at which a chain of islands between North and South America rose out of the water to form the isthmus.

It is known that land animals were crossing the isthmus by the beginning of the Pleistocene period. It is probable that the last part of the landbridge rose in the late Pliocene, some three million or four million years ago.

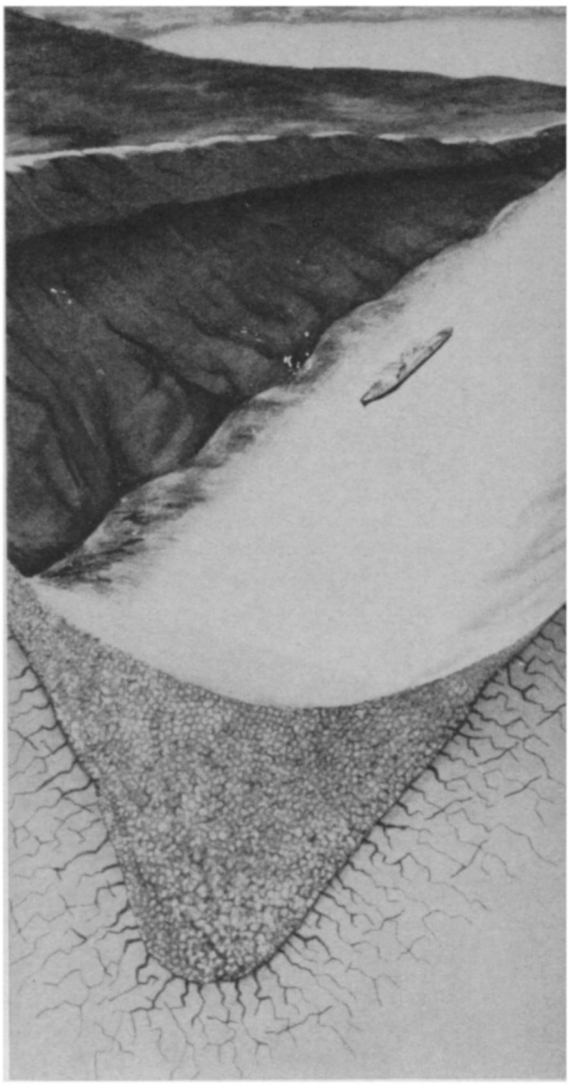
Before then Pacific and Atlantic fauna merged at this point. Even though conditions on the two sides of the impending landbridge were quite different, there was such free access that interspecies conflicts presumably were resolved and most species were found in both areas.

After the barrier was complete, the flora and fauna on either side continued evolving. Chance, isolation and the different environments caused di-

Pelamis platurus, a venomous sea snake, may migrate to tropical Atlantic through canal. Map shows principal routes still under consideration. Cross section shows how a row of nuclear blasts can form the channel.



U.S. Army



Lawrence Radiation Laboratory

vergence in the evolutionary paths taken by Atlantic and Pacific groups of what were initially the same species.

Speciation, the divergent evolution of two closely related organisms to the point that they are no longer able to mate, takes a long time. So it is rare that biologists can get a controlled look at it in progress. Variants of one species may not all be known, or may be separated widely in space, or the forces which produce genetic divergence may not be understood in a particular case, and so on. The researcher usually has to be content with a static look at a dynamic process.

The landbridge is geologically recent so that speciation still is in its early stages. In most cases the parent species still exists somewhere. Comparison of the quite-different environments on either side of the isthmus tells a lot about the environmental forces involved. Ecologists, now developing a sense of urgency, would like to know more before the environment is altered.

Bearing in mind that total or partial behavioral barriers to reproduction will have developed among Panama's variants, species and quasi-species, Dr. Ira Rubinoff, assistant director for marine biology at the Smithsonian Institution's Tropical Research Institute in Balboa, Panama, expects four possible, but not mutually exclusive, outcomes to biota mixing through a sea-level canal.

- Where there are no barriers, variants may interbreed to produce viable hybrids. These might stay in a small area, or prove able to spread over their parents' ranges, perhaps displacing them.
- Where there are no behavioral barriers, but where speciation has progressed to some degree, it may yet be possible to breed. However, because of incompatibility of the parent genes, genetically inferior hybrids may result. These could be successful enough in the short run to displace their parents, yet be unable to survive in the long run. Thus both parents and hybrids could become extinct.
- If some barriers have been developed, speciation is likely to be fairly advanced. Mating might occur occasionally, but usually without success. Because of basic similarities in needs and habits, however, the two groups would compete and one or the other might become extinct.
- If full speciation has occurred, interbreeding will not occur. Again, however, competition between similar species could lead to extinction of one or the other.

Besides the problem of mixing cousins, it is possible that one alien predator of some kind could disrupt the life cycle of a totally different species, as was the case in the Great Lakes. There are a shrimp fishery and a mackerel fishery on the Pacific side, for instance, that are not found on the Atlantic side. A predator to either or both might migrate through a canal and wreak havoc, though this is not considered too likely because similar predators occur on both sides.

A creature of a different hue is timid *Pelamis platurus,* a snake found in all tropical seas except for the Atlantic. Though *Pelamis platurus* is timid and an inefficient biter, the reptile is a member of a group of totally marine snakes which possess the most toxic of all snake venoms. Dr. Rubinoff says this snake might find its way through the canal and produce a population explosion in the Atlantic, which it might find free of natural enemies.

Examples of groups thought to have completed speciation since the land-

Gatun Lake, 1919: The first canal wrought ecological changes as the lake filled.

Smithsonian

Rubinoff and colleague gather fish in Gatun Lock for ecology studies.

bridge appeared are the marine gobies *Lophogobius cristulatus* in the Pacific and *L. cyprinoides* in the Atlantic. The latter, incidentally, is the only marine fish known to have successfully colonized the opposite ocean through the existing canal. At the other, zero end of the speciation scale, the crab *Grapsus grapsus* is found on both sides of the isthmus.

A sea-level canal might cause physical changes in addition to the biological changes. The Pacific side of the isthmus generally experiences much greater tide fall than the Atlantic side. The Atlantic there is warmer than the Pacific. A net flow of colder water from Pacific to Atlantic might be expected which could alter the Caribbean environment.

"At the very least," Dr. Rubinoff says, "the resident population and the new immigrants will have to make rapid adaptations. The influx of new organisms could upset the balance of populations, and certainly would change the nature of the selection to which organisms are subjected.

"We can expect an increase in the process of extinction of some species and their replacement by others. The population dynamics of some commercially important species may be disrupted."

No one is suggesting that for the sake of a few species and subspecies of fish the canal plans should be compromised; the size of today's ships and the volume of traffic make a sea-level canal already overdue. What the Smithsonian ecologists urge is that as much as possible be learned of the existing situation before such a massive change is introduced.

They point out that the canal can be considered an ecological experiment without parallel. This can only be so, however, if the pre-canal situation is known so it can serve as a base line.

And finally, a thorough study might reveal a potential disaster of Welland Canal proportions that could be forestalled without affecting the usefulness of the canal. Perhaps, for instance, some simple electric barrier could keep the sea snake in the Pacific.

Who should conduct such studies as are recommended is still up in the air, though the Smithsonian expects to be the coordinating agency for them. The Interior Department and other Federal agencies are interested in at least part of the action, provided they

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Rubinoff with specimens.

can find the money. The Tropical Research Institute has begun some research, but Dr. Eugene Wallen, head of the Smithsonian Office of Oceanography, says it is an inconsequential amount compared with what has to be done.

Dr. Wallen says the base line studies being called for are vital, but long term followup studies also will be needed to reap the knowledge that can be gained from the canal.

An Army spokesman involved in the canal feasibility studies says biota mixing disasters are not expected because of the similarity of the two fauna. The Army maintains that temperature differences are inconsequential and that there will be little net flow through the canal. Most of the water, it believes, will simply slash back and forth in the canal as Atlantic and Pacific tides rise and fall.

Dr. William E. Martin, an ecologist and the technical director of Battelle's environmental studies, says that an additional safety margin is contained in the fact that the most valuable fisheries are in the Pacific. Because of the direction of net flow most of the mixing will occur in the Atlantic, he contends.