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## Paleontologic field work between Atlantic and Pacific

by PETER JUNG 1)

1 Figure

The two parts of the American double continent are connected by the thin landstrip occupied by Panama and Costa Rica. Geologically this land bridge is very young, its age being slightly more than 3 Ma. Before this North and South America were separated. The gradual rise of the Central American Isthmus had a two-fold effect:

- On one hand a corridor was established, which allowed the terrestrial faunas and floras to migrate to the other continent. These migrations and their effects are quite well known.
- On the other hand this land bridge cut in two the tropical water body of a formerly coherent ocean with a homogeneous, marine faunal province. The effects of this barrier on the evolution of the marine faunas in the newly formed Caribbean faunal Province in the East and in the Eastern Pacific faunal Province in the West are largely unknown owing to the virtual lack of relevant investigations.

In connection with the plans for the construction of a new sea level canal across the isthmus the director of the Smithsonian Tropical Research Institute in Panama, IRA RUBINOFF, discussed the necessity to carry out careful studies on potential biological effects *before* the construction of the canal, i.e. the study of the mixing of the two now isolated, amphi-American, tropical faunas and its effects. He pointed out that otherwise «an opportunity for the greatest biological experiment in man's history may not be exploited» (RUBINOFF, 1968, p. 857).

It might be added here that an analogous situation has existed in the area of the canal of Suez, which was completed in 1869. In his book «Lessepsian Migration» FRANCIS D. POR (1978) regrets that at that time no faunal inventories of the Red Sea and the Eastern Mediterranean existed and that «even now, more than a century later, the records are still incomplete» (POR, 1978, p. 30).

Coming back to the «greatest biological experiment in man's history» of RUBINOFF (1968, p. 857) it is necessary to say that from a paleontological perspective this experiment has already been carried out in the reverse sense, when the Central American land-bridge became effective about 3.1 Ma ago.

The result of the separation of the Caribbean from the Eastern Pacific faunal Province can be read from the living faunas provided they are studied carefully. To get to know the various steps of a divergent evolution should be possible by studying the fossils preserved in Pliocene, Pleistocene, and Holocene sediments from both sides of the Central American land-bridge. For this purpose as many sections as possible of the

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relevant ages have to be visited, described, and measured, and their fossil content collected and then worked up. It is easy to plan such a sequence of work to be done, but to actually do it is a much more difficult task.

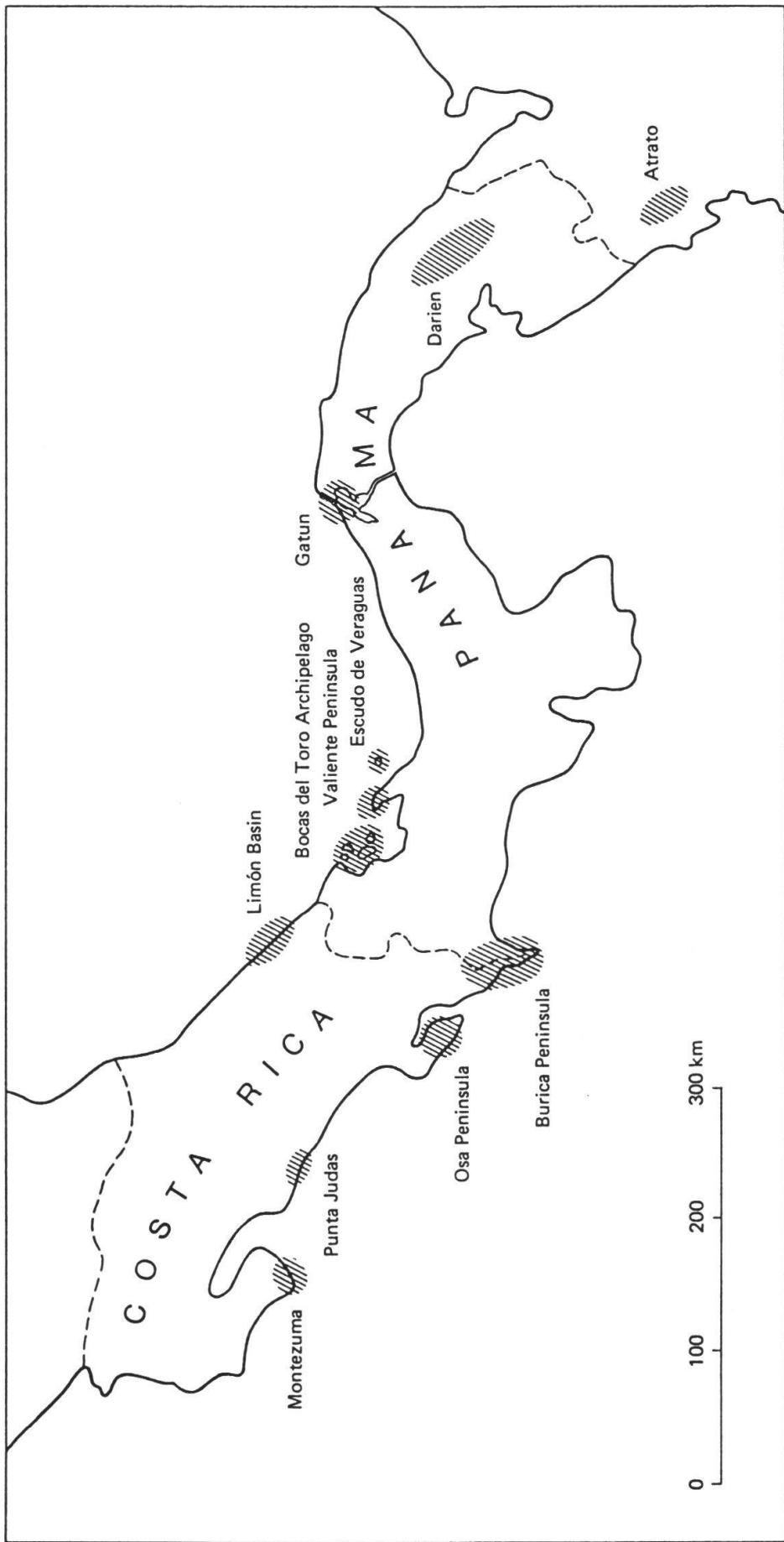
However, two men — it must have been in 1985 — discussed these thoughts and decided to start a project with the goal to study the evolutionary effects on marine invertebrates due to and since the separation of the tropical Western Atlantic from the Eastern Pacific. The project was soon called PPP, i.e. Panama Paleontological Project. The two men are TONY COATES, a British geologist and coral specialist working at George Washington University, Washington D.C., and the American JEREMY JACKSON working for the Smithsonian Tropical Research Institute in Panama as a marine biologist and bryozoan specialist. In January 1986 the two scientists made a first reconnaissance trip to various areas in the Republic of Panama to check on the abundance of fossils and their state of preservation in the relevant sections. Satisfied of their first field work for this project they subsequently asked me to join them in the study with the understanding that I was to work up the collected molluscs or to see to it that they were going to be worked up by others. On the other hand the Natural History Museum Basel should obtain the right to keep the collected molluscan faunas. I accepted the proposal, and in August 1987 the first period of my field work for this project took place. During the years 1988 and 1989 four additional field trips of two to three weeks duration each were undertaken, this time with an increased number of participants.

It is obviously not possible to present results at this moment, because the project is still in its initial phase. The faunas so far collected are curated, but not a single fossil has been studied in any detail yet. The areas of field work for this project are plotted in Figure 1. With the exception of the Osa Peninsula, the Darien region (Rio Chico and Rio Chucunaque), and the Atrato region, all the areas have been visited. However, in some of them the field work has not yet been completed.

In order to illustrate the kind of results that can be expected of the Panama Paleontological Project I would like to draw attention to a recently published monograph on the columbellid gastropod *Strombina* and related genera (JUNG, 1989), in which 98 fossil and living species are revised. *Strombina* and its relatives are 5 to 50 mm high marine gastropods living mostly in shallow water. Their geographic distribution is restricted to tropical America, and stratigraphically they are known from the late early Miocene to Recent. They therefore have a history of a little less than 20 million years.

The study of this group has shown that after the emergence of the Isthmus of Panama mass extinctions occurred during Plio-Pleistocene times in the Caribbean part of the formerly large faunal province. This fact was known from other groups of marine animals for some time already. It is also known that during these critical times the diversity of species in the Eastern Pacific part of the province was very high. The modern tropical province of the Eastern Pacific, the Panamic Province, is almost entirely isolated from other tropical provinces, and yet it sustains a fauna of shallow water molluscs of about 3000 species despite the shelf being narrow. During the past decades a number of authors have commented on possible reasons for the mass extinctions in the Caribbean part of the province during Plio-Pleistocene times. The following is a list of some of the reasons brought forward:

1. Change of the sea water temperature.
2. Change of the oceanic circulation and exclusion of Eastern Pacific waters in the Caribbean.
3. New pattern of food supply.
4. Reduction of food supply.



**Figure 1** Outline map of Panama and Costa Rica showing areas of prime importance to the Panama Paleontological Project.

5. The glaciation of the northern hemisphere led to a general lowering of the sea level. The shallower parts of the Caribbean Sea became therefore situated above sea level causing extinction of many species and forcing others to withdraw into deeper parts of the basin.
6. Drop of water temperatures as a consequence of the beginning glaciation of the northern hemisphere.
7. The exchange of surface waters between Atlantic and Pacific was increasingly restricted 3 to 4 Ma ago.
8. The restricted circulation of surface waters between the water bodies of the Atlantic and Pacific probably led to increased salinity in the surface waters of the Caribbean Sea during early Pliocene times.

In recent years STEVEN STANLEY, a paleontologist at Johns Hopkins University, has studied this problem in more detail. For him it is evident that the main reason for the mass extinctions in the Caribbean is the climatic cooling during Plio-Pleistocene times due to the glaciation of the northern hemisphere (STANLEY, 1986, p. 23). He cited estimates, according to which the surface water temperatures in the central Caribbean were 4° C lower than today during the last Pleistocene glaciation. This means an even greater drop in comparison with the especially warm temperatures of early Pliocene times (STANLEY, 1986, p. 27). This fact must have affected fully stenothermal species drastically. Stanley also lists arguments, according to which regression alone, i.e. the lowering of the sea level and thus the areal reduction of the shelf seas, cannot be a major reason for mass extinction. Loss of habitat and areal reduction of the continental shelves due to regression do not necessarily lead to the impoverishment of shallow water faunas. This is shown alone by the rich shallow water fauna of the modern Panamic Province, which lives on a narrow shelf.

Stanley is also pointing out that the Caribbean may have been a trap for fully tropical species: in the North there was a clear temperature barrier, which prevented escaping in that direction. In a southeasterly direction, towards northern Brazil, escape may have been possible despite many obstacles. However, it has to be added that in this area the proto-Orinoco and the proto-Amazon must have influenced the salinity of the shelf areas in a negative sense for any shallow water inhabitant.

Comparing the situation in the Caribbean with that in the Eastern Pacific, where no mass extinctions occurred, we can see the reason in the fact that the Eastern Pacific shallow water faunas are able to react to climatic changes by migrating freely in a southerly or northerly direction.

There is no doubt that the study of the rich materials collected during field work for the Panama Paleontological Project will yield a number of similar and other results based on different groups of marine invertebrates.

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