## Panbiogeography and conservation of New Zealand's natural history

*John R. Grehan,*
Buffalo Museum of Science, 1020 Humboldt Parkway, Buffalo, New York 14211-1293, USA

Panbiogeography is an internationally recognized research program for the geographic study of plant and animal distributions. The research program began in the 1950's through the work of the Franco-Italian botanist Leon Croizat. During the 1980's panbiogeography entered the New Zealand scene through the pioneering efforts of Robin Craw and Michael Heads. The ensuing growth and productivity of research, generated almost entirely within New Zealand, culminated in 1989 with the world's first panbiogeography symposium sponsored by the Museum of New Zealand.

Through the 1990's New Zealand panbiogeography became very influential internationally, leading to an expanding research program with particularly strong support from scientists in Latin America, Europe, and the South Pacific. If one were to look for a continued presence within the New Zealand literature, however, it would largely be in vain. In consequence I find myself in the incongruous position of writing (at the kind invitation of J. Bastow Wilson) this little note on a subject that should otherwise be well known and understood. Just as one cannot, in a few words, make a complete summary of modern genetic or systematic theory, I will not pretend this note offers anything more than a hint of the possibilities for the natural sciences in New Zealand.

Based on the very simple idea that geographic patterns are informative about earth history, panbiogeography represents distributions by graphs, called tracks, that link disjunct localities together to provide information on the spatial structure of the distribution. Tracks are correlated with overlapping tectonic or geomorphological features (called baselines) to make biogeographic predictions concerning geological history. It is even possible to predict new geological facts as Croizat did in 1958 for the Americas where he predicted the continents were made up of a fusion of terranes of Pacific and Atlantic origin. This prediction conflicted with geological theory of the time, but later received confirmation by geologists.

New Zealand's geohistory is widely portrayed as an inherited Gondwana biota with the addition of later waifs and strays. Panbiogeographic research suggests New Zealand inherited at least two different biotas - one centered on the tectonic basins now forming the Indian and Atlantic Oceans (e.g. ratite birds) the other centered on the tectonic basin now forming the Pacific (e.g. tuatara, southern beeches, primitive frogs). The presence of both groups in the New Zealand biota is concordant with a geological model involving accretion of Pacific terranes to the eastern margins of Gondwana preceding the separation of New Zealand from Australia and Antarctic. This hybrid origin continues to leave its Mesozoic footprint upon New Zealand's modern ecological landscape.

Many puzzling disjunctions in the distributions of New Zealand organisms can be resolved into a series of concentric tracks linking different parts of the mainland and

nearby islands. One component of this Parallel Arcs Model involves the Chatham Islands where some groups form a Chatham-eastern South/North Island track while other form a Chatham southeastern South Island and sub-Antarctic track (Fig. 1). Intersection (called a node) of the tracks in the Chathams and southern South Island has its geological parallel in the suturing of Pacific and Gondwanic terranes in both the mainland and Chatham Islands. This geological correlation leads to the biogeographic prediction that the distributions co-evolved with the geological formation of New Zealand in the Mesozoic and millions of years of subsequent geological upheaval have not obliterated their tectonic provenance.

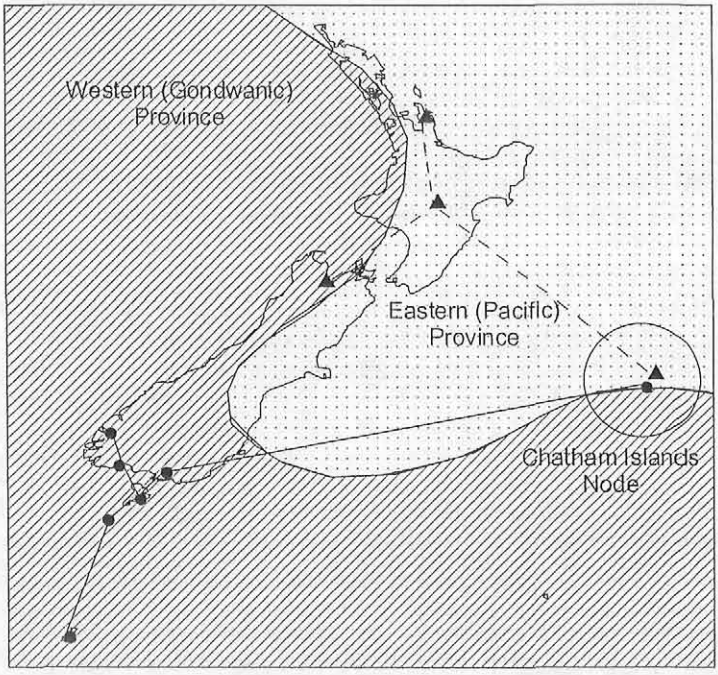


**Fig 1**. Highly generalized map for two of New Zealand's major geological sectors involving a western (Gondwanic) province and eastern (Pacific) province, and their spatial correlation with different standard tracks. Example distributions represented here by the beetle *Notochoragus nanus* (solid circles) for the western track, and moths of the *Exeiratus setarisus* species group (triangles) for the eastern track. The two patterns are statistically significantly different from a random distribution ($p < 0.04$) using the Clique-Compatibility Program (Craw, 1989). This biogeographic correlation suggests the distributions coevolved with the formation of New Zealand's geology in Mesozoic times and the occurrence of both groups in the Chatham Islands is a consequence of its composite geological structure.

One may refuse to believe in biogeographic stability over the millennia because it does not agree with one's beliefs about fossils, molecular clock theory, or geological narratives. The other course is to consider biogeography as an independent historical science generating new insights that questions the validity of long-held traditions. Perhaps fossils are not the last word on the age of a biota. Perhaps molecular clock assumptions are sometimes misleading, and perhaps the lack of geological evidence is not exclusive of other historical alternatives. The maps of panbiogeography are as factual a source of evidence as any one may find in evolutionary biology, and it is by the critical study of these maps that the integration of geography, biology, and geology may move forward.

Correlation of tectonic and biological patterns has major implications for understanding the evolutionary significance of animal and plant distributions since biodiversity has evolved geographically. Panbiogeography provides a method of documenting the spatial structure of biodiversity and analyzing its potential historical and evolutionary significance. Without this method conservation science in New Zealand lacks the biogeographic resources necessary for implementing a management program capable of managing and conserving both the physical form (organism) and spatial (geographic) structure of organic distributions.

Panbiogeography might be far better known in New Zealand if it were not denied research funding or locked out of the scientific and popular literature. These are troubling times for the science of New Zealand's natural history. There is an evident need for accountability from the institutions of research funding and publication within New Zealand. Only then will there be a fully informed scientific growth for the conservation of New Zealand's remarkable natural history.

**Selected References**


Craw, R. C. 1989. Continuing the synthesis between panbiogeography, phylogenetic systematics and geology as illustrated by empirical studies on the biogeography of New Zealand and the Chatham Islands. *Systematic Zoology* 37: 291-310.

Craw, R. C., Grehan, J. R., Heads, M. J. 1999. *Panbiogeography: tracking the history of life.* Oxford University Press, New York.

Matthews, C. 1990. Special issue on panbiogeography. *New Zealand Journal of Zoology* 16: 471-808.

Grehan, J. R. 2001. Biogeography and Evolution of the Galapagos: integration of the biological and geological evidence. *Biological Journal of the Linnean Society* 74: 267-287

Heads, M.J. 2001. Birds of paradise, biogeography and ecology in New Guinea: a review. *Journal of Biogeography* 28: 1-33.

Llorente, J., and J.J. Morrone. 2001. *Introducción a la biogeografía en Latinoamérica: teorías, conceptos, métodos y aplicaciones.* Universidad Nacional Autónoma de México, México, D.F.