



Ricardo Mañé, 1948 - 1995

On Ricardo Mañé

by Ricardo Mañé^(*), 1948 - 1995

Ricardo Mañé was born in January, 1948, in Montevideo, Uruguay. He entered the University of the Republic of Uruguay in 1967. In 1969 he became an assistant lecturer in the department of mathematics, where, under the guidance of J. Lewowicz he found his vocation for mathematics and specially for dynamical systems. Through him he got in contact in 1971 with J. Palis, who was then starting a lively research group in this field at the Institute for Pure and Applied Mathematics (IMPA) in Rio de Janeiro. He encouraged Mañé to pursue his studies at IMPA, which he did, obtaining his PhD in 1973, having Palis as thesis advisor.

His thesis was connected with the vast research that had taken place in the previous decade but was still being developed around the concept of hyperbolic dynamics, introduced by S. Smale around 1963. One of the main aspects of this research was the use of hyperbolicity to grant the persistence of specially interesting features of a dynamical system under small perturbations. Uppermost in this line of research was structural stability, roughly speaking the property of a dynamical system having an orbit structure that remains topologically unchanged when the system is slightly perturbed. In 1968, Palis and Smale, in the light of their own joint work on the structural stability of Morse-Smale systems, and that of Anosov on the class of systems that nowadays carries his name, conjectured that a combination of hyperbolicity of the recurrent orbits plus certain transversality assumptions on the transient trajectories were necessary and sufficient conditions for structural stability: This became a fundamental question in dynamics known as the Stability Conjecture. In full generality, the sufficiency was proved in the papers of Robbin (1971), de Melo (1972) and Robinson (1973). The necessity remained open until much later. Its conceptual nature and part of its technical difficulties were present in Mañé's thesis, where he solved a similar but simpler problem, proving that the hyperbolicity assumption, shown by several authors, among them Hirsch, Pugh and Shub, to be sufficient for the persistence of an invariant manifold of a dynamical system, was also necessary. After many partial results, notably those of Franks, Pliss, Liao and Sannami, the completion of Stability Conjecture for diffeomorphisms was done by Mañé in 1986 [a masterpiece, and in

(*) Bracket by Jacob Palis.

Mañé's own words, the focusing point of his contributions to dynamical systems]. Based on that, Palis extended the result to the limit set. The long path to this theorem put Mañé in contact with many other challenging phenomena of which several are still topics of active research nowadays, like persistently transitive dynamical systems, the creation of attracting periodic orbits by small perturbations, the generic theory of Lyapunov exponents. This research inspired Mañé to write several works on ergodic theory (mainly on entropy and Lyapunov exponents) of differentiable dynamical systems, geodesic flows and rational maps.

His research also dealt with another open problem analogous to the Stability Conjecture for rational maps, that asks whether the hyperbolicity of the Julia set is necessary for its stability (the sufficiency was proved in 1968 by Guckenheimer). A combination of the joint work of Mañé, P. Sad and D. Sullivan, with his proof of the instability of Herman rings (1985) and the important papers of Sullivan on the role of quasi-conformal mappings in dynamics, prove that when the Julia set has measure zero, stability implies its hyperbolicity.

Finally, Mañé has worked more in recent years, on variational ergodic theory of conservative dynamical systems, especially following a basic work of Mather on minimizing measures for Lagrangian systems.

In 1982, he published the book *Introdução à teoria ergódica*, that in 1987 was translated into English and published by Springer-Verlag in the *Ergebnisse der Mathematik* series. Two essays were to follow: *Global variational methods in conservative dynamics*, Notes of the Brazilian Mathematical Colloquium - 1991, and *The dynamics of inner functions*, with C. Doering, *Ensaio Matemáticos - Brazilian Mathematical Society*, 1991.

Since he became an assistant professor at IMPA, in 1973, all the academic career of Mañé was developed at this admirable Institute, where he has been thesis adviser of eleven doctorate students C. Doering, A. Araújo, R. Ruggiero, M. Craizer, G. Contreras, M. Paternain, F. Carvalho, A. Rovella, J. Delgado, R. Iturriaga and H. Enrich. The topics of their theses included persistently transitive flows, Lorenz like attractors, existence of hyperbolic attractors for diffeomorphisms of surfaces, the dynamics of the inner functions and the variational ergodic theory of Lagrangian flows.

Mañé was invited to speak twice in the section of Ordinary Differential Equations and Dynamical Systems of the International Congress of

Mathematicians, in 1983 at Warsaw and in 1994 at Zürich. He was also a speaker at the Colloquium organized by the Société Mathématique de France, celebrating R. Thom's 65th anniversary. In 1994, he became a member of the Brazilian Academy of Sciences and was awarded the Third World Academy of Sciences Prize for Mathematics.

Note by J. Palis. Ricardo Mañé was one of the most brilliant mathematicians ever in Latin America. In the words of L. Carleson, he had a unique approach to mathematics and will have no substitute. Certainly not. Yet, his powerful intellect will be with us for many years to come: He permanently influenced the area of dynamical systems as well as his friends, colleagues and students at his so much loved IMPA, to which he had always been adamantly faithful. We all remember him as a wonderful and most inspiring lecturer. Also as a funny and often ironic story teller, incredibly sharp, intelligent and knowledgeable (a compulsive reader), as well as a profound connoisseur of opera. In brief, a most unforgettable human being and mathematician.

Mañé left us in March, 1995, about a year after he prepared the above text, upon request of The Third World Academy of Sciences.