Embryo size variation in larger foraminiferal lineages: stratigraphy versus paleoecology in *Nephrolepidina praemarginata* (R. Douvillé, 1908) from the Majella Mt. (Central Appennines)

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**ABSTRACT** - The Mediterranean *Nephrolepidina* lineage has been thoroughly investigated in a number of studies. Here, we investigate biometrically two late Rupelian *Nephrolepidina* populations (E77', n=54; E76J, n=9) from the northern Majella Mt. (Central Italy), considering three parameters and three factors and their mean values. The A factor (degree of enclosure of the deuteroconch on the protoconch) and the parameter C (number of adaxial chamberlets) suggest that both populations belong to *N. praemarginata* (R. Douvillé, 1908). The mean sizes of protoconch and deuteroconch are distinctly larger than other known populations of *N. praemarginata*. This is interpreted to reflect environmental factors.

Increase in embryo size is a general feature among many larger foraminiferal lineages. In addition, studies on recent larger foraminifera indicate that embryo size varies along the depth gradient; however, this variation is poorly investigated. In recent nummulitids, the diameter of the embryonic chambers may either increase up to the ecological optimum and then decrease, or increase linearly with depth.

Investigating embryo size may thus be rewarding either in a sequence of populations when sea-level change occurs or when anomalously large values of embryo size are attained in a population.

Utilizing evidence from models derived from recent species, although it is uncertain how far they can be extended to extinct radial foraminifers, and sequence stratigraphy, it is inferred that the two populations come from a depth not far from the ecological optimum of the species. Recognition of this ecological optimum in the fossil record is generally hampered by conspicuous transport and mixing along the depth gradient.

**KEY WORDS:** biometry, paleoecology, larger foraminifers, *Nephrolepidina*, Oligocene, Majella

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**INTRODUCTION**

*Nephrolepidina praemarginata* was originally described by R. Douvillé in 1908 on isolated specimens from the lower Oligocene marls of Dego (Liguria, Italy) and later biometrically investigated by De Mulder (1975), Matteucci and Schiavinotto (1977) and Schiavinotto (1978) from other Mediterranean localities. The biometric approach according to the rationale outlined in Drooger (1993) is linked to the conventional boundary fixed by De Mulder (1975), who subdivided the late Rupelian-Burdigalian phyletic lineage of *Nephrolepidina* in the Mediterranean area into three chronospecies: *N. praemarginata*, *N. morgani* (Lemoine and R. Douvillé, 1904), and *N. tournoueri* (Lemoine and R. Douvillé, 1904). This approach of subdividing a lineage into chronospecies for biostratigraphic purposes is illustrated by the diagram of Drooger and Rohling (1988) (here redrawn and modified in Fig. 8). The biometry of *N. morgani* and *N. tournoueri* has been investigated in detail by several authors (e.g., Serpagli and Sirotti, 1966; Schiavinotto, 1979; Schiavinotto and Verrubbi, 1994; Giannini et al., 2007). In contrast, less is known about *N. praemarginata* and especially about its ancestor(s).

Modern Oligo-Miocene larger foraminiferal biostratigraphy has been established by combining first and last occurrences of various taxa and chronospecies of radial foraminifers lineages (Drooger and Laagland, 1986). Revision and correlation of these data with independent biozonal schemes, sequence-stratigraphic data and magnetostratigraphy allowed Cahuzac and Poignant (1997) to establish biochronozones for this timespan in the frame of the Mediterranean Tethys* Shallow Benthic Zonation (SBZ). Future developments of the Paleogene time scale (Luterbacher et al., 2004) are likely to determine significant changes to this zonation, especially as concerns the Rupelian-Chattian boundary.

Sequences of fossil populations of radial larger foraminifers represent classical examples of evolutionary processes such as nepionic acceleration (Tan Sin Hok, 1936), consisting in the reduction of the ancestral spiral, and embryonic acceleration (Drooger and Freundenthal, 1964), defined as the trend of the deuteroconch to increase its degree of embracement on the protoconch becoming globular (circular in equatorial section). Obviously, both embryonic chambers in *Nephrolepidina*, the protoconch and the deuteroconch, tend to increase in size according to embryonic acceleration, although studies on recent larger foraminifers show the variation of the diameter of the protoconch along the depth gradient (Fermont, 1977a, 1977b; Fermont et al., 1983; Reiss and Hottinger, 1984; Yordanova and Hohenegger, 2004).

The bathymetric distribution of larger foraminifers is strictly linked to light intensity, activity of the symbiotic algae, productivity, and population density (Fermont et al, 1983; Reiss and Hottinger, 1984; Pécheux, 1995).