

MICROPALAEONTOLOGY NOTEBOOK

Spirals: their orientation and description

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The trochoid coiling mode is the most dominant amongst hyaline foraminifera. The parallels in shape with especially gastropods neatly explains the use of the same terms to describe the spiral coiling. Other terms came in use, at first well-defined, but gradually losing their precision. Because of growing demands of systematics and changes in stress of use and value of characters, the inadequacy of this terminology has become a stumbling block. The terms ventral/dorsal and spiral/umbilical denote different things and are therefore all useful: the latter pair should not be relinquished as suggested (Haynes, 1990: 512). Historically, the terms ventral/dorsal and upper and lower side have been used by most students of the foraminifera with only few exceptions (notably Reuss and Loeblich & Tappan). Despite the protist nature of foraminifera, dorsal and ventral continued to be used, analogous to terms used to describe, for example gastropods. Far fewer problems beset the terms spiral and umbilical, which are generally defined (*Oxford English Dictionary*) as:

spiral *a. n. & v. 1. a.* Coiled; winding about a centre in an enlarging or decreasing circular motion, either on a flat plane or rising in a cone.
spire *n.* Spiral, coil; single twist of this; upper part of spiral shell [F. f. Lf. Gk *spira* coil]
umbilical *a. 1.* Of, situated near, affecting, the umbilicus **2.** Centrally placed.
umbilicus *n.* Navel; (Bot. & Zool.) navel-like formation; (Geom.) point in a surface through which all cross-sections have same curvature [L., rel. to Gk *omphalos*]

ORIENTATION: A GEOMETRICAL AND BIOLOGICAL PERSPECTIVE

Extending spirals into 3 dimensions is straightforward (Fig. 1). Looking along the z-axis in the direction of expansion of the curve, one obviously sees the spire, with the opposite view yielding the umbilicus. These terms describe the same 'side' of the spire irrespective of the frame of reference. Hence, spiral and umbilical are terms with a clear, geometric meaning. Organisms, contrary to mathematical entities, have to orientate themselves relative to the substrate on which they live. Since there is a dorsoventral asymmetry in animals, 'up' and 'down' have always been characterized by the term dorsal and ventral. Quite naturally, these terms were extended to denote other parts of the organism; e.g. dorsal and ventral valve in Brachiopoda as opposed to left and right valve in Ostracoda. There is no problem in generalizing the use of these two terms to denote the side pointing away from the substrate as dorsal with the opposite being ventral. Extending the use of all these terms to foraminifera should be unproblematical. Unfortunately, biology and geometry have contaminated each other. The glossaries provided by Loeblich & Tappan (1964, 1987) illustrate this well:

dorsal: opposite to ventral side; spiral side of trochoid forms
ventral: pertaining to inferior side of test, commonly used for umbilical side;
opposite to dorsal; commonly apertural side
spiral side: part of test where all whorls are visible
umbilical side: involute side in trochospiral forms; commonly with aperture.

Strictly speaking, dorsal and ventral are meaningless in a protistean context. However, it is quite legitimate to use terms on the basis of parallels in overall shape and perceived analogies. But the analogous nature has to be clearly understood and use of the terms properly circumscribed. In practice this did not happen: not only is there a confusing of spire orientation with life position, the position of the aperture clouds the issue even further. This resulted in describing the flat side of *Cibicides* as the dorsal side (Cushman, 1940: 497; Haynes, 1981: 261), while that is in reality the ventral side, as the organism lives attached, 'upside down'. The overall shape of the test is in this respect misleading. This is further illustrated by looking at the pyramidal tests of *Rotalia*, *Pseudorotalia* and *Cibicides*. The flattened side in *Rotalia* (Fig. 2b) is the ventral side, the side with the aperture and, from sections, the umbilical side. In *Pseudorotalia* (Fig. 2a), the flattened side is the spiral and dorsal side, with the aperture on the ventral, umbilical side. But in *Cibicides* (Fig. 2c), the flattened side is the ventral, spiral side, which is also the side where a substantial part of the aperture occurs. Interestingly, the last of the four combinations does not occur in foraminifera: no test combines the features of a flat, dorsal umbilical side (an 'upside down' *Rotalia*) (Fig. 2d).

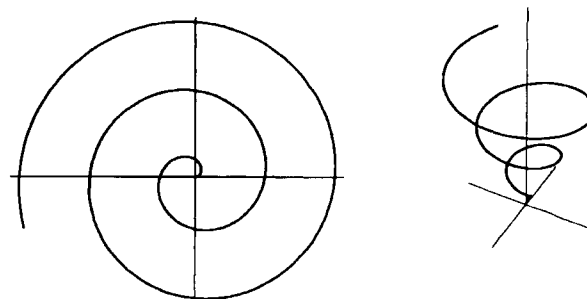


Fig. 1. Extending a spire from 2 to 3 dimensions.

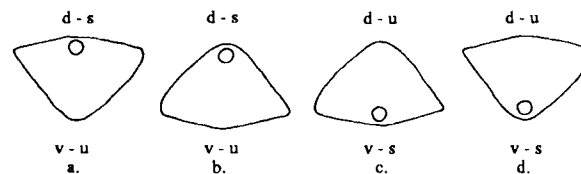


Fig. 2. All possible combinations of spiral/umbilical (s, u) and dorsal/ventral (d, v). Note position of the proloculus.

Recognizing the direction of coiling should therefore rely not on grossly external features, but on the actual positioning of successive chambers with respect to the proloculus. Ideally, connecting the centre of gravity of successive chambers will define coiling unambiguously. In case of doubt, X-ray photography or thin sections, maybe even serial thin sections, will solve the problem. The terms spiral/umbilical and ventral/dorsal describe different characteristics of the foraminiferal test. Spiral and umbilical are used to orientate the spire geometrically and provide a frame of reference in which to describe other features of the test. Ventral and dorsal are terms with a biological connotation, and they refer to the life position of the test. Very often, both sets of terms will be correlated, but it is not an organic correlation.

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