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The Spiral in the Tusk of the Narwhal

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ABSTRACT. The spiral in the tusk of the narwhal has been fancifully, but never satisfactorily, explained. Spiral growths are common in the animal kingdom and share the feature of having straight axes. A curved tusk would hinder the narwhal swimming; a spiral mode of growth ensures overall straightness even if the tusk grows irregularly. The need to keep the tusk straight completely and satisfactorily explains the spiral.

Key words: *Monodon monoceros*, dentition, morphology, asymmetry

RÉSUMÉ. On a expliqué le fait que la corne du narval soit spiralée de manière originale mais jamais satisfaisante. Les croissances en spirale sont un phénomène commun dans le règne animal et elles possèdent toutes la caractéristique d'avoir des axes rectilignes. Une corne incurvée gênerait la nage du narval; une croissance spiralée assure que l'ensemble est rectiligne même si la corne pousse de façon irrégulière. La nécessité pour la corne de pousser droit justifie entièrement et à elle seule le phénomène de la spirale.

Mots clés: *Monodon monoceros*, dentition, morphologie, asymétrie

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The tusk of the narwhal (*Monodon monoceros*) is remarkable in several ways: it is unique among the whales; it is straight; it usually only develops on the left side; and when, rarely, both left and right tusks develop, they both twist left-handed instead of mirroring each other (Thompson, 1942). Its phylogeny and function have aroused much discussion (Thompson, 1942; Silverman and Dunbar, 1980; Best, 1981; Gerson and Hickie, 1985); we do not here add to that, but intend only to suggest a reason for the conspicuous spiral.

Although almost every writer on narwhal has remarked that the tusk spirals, few have suggested why. The only reasoned explanation for the spiral was given by D'Arcy Thompson (1939, 1942), who thought that asymmetrical propulsion from the tail might cause it and suggested the same cause — asymmetrical propulsion — for the asymmetry general in the skulls of odontocetes. This would explain why right-hand tusks should break symmetry and twist the same way as left-hand. Pilleri (1983) credited Thompson's explanation for the spiral so far as to measure the moment arm of the tail stock and flukes. We doubt this explanation. Neither author gave more than a heuristic assessment of plausibility for it nor a rational mechanical explanation; Pilleri (1983), after measuring the moment arm, presented no subsequent calculations of its effect. No one has developed Thompson's hypothesis quantitatively, and other authors have found no evidence for asymmetrical propulsion. The asymmetry in the skulls of odontocetes, developed recently (Ness, 1967), is associated with their refined acoustic capabilities (Mead, 1975; Gaskin, 1982); mysticetes have symmetrical skulls.

The narwhal tusk is a tooth, and long teeth grow by continued deposition at the root. Unless the rate of deposition of new material were perfectly balanced all around the root, a curved tusk would result, and such a long tusk, if curved, would hinder the narwhal when swimming. One feature of narwhal tusks is that they are overall almost perfectly straight (Thompson, 1939, 1942; Ness, 1978; and see, for example, Tafel 17 in Pilleri, 1983); so are other forward projections among aquatic animals, such as the spears and saws of the billfishes and sawfishes (Norman and Fraser, 1937). If the tusk twists as it grows, each point around the tusk passes in turn over regions in the socket of faster and slower growth, and any imbalance of growth rate around the tusk base is evened out; the result is a straight axis.

Spiral structures with straight axes are common in the animal kingdom (Thompson, 1942; Illert, 1983), as horns, shells, teeth, and tusks: ". . . the seashell, the elephant's tusk, the beaver's tooth, even the claws of a canary, all have in common the way in which they are produced" (Illert, 1983: 22). They are those that, like the narwhal tusk, grow at the base only and maintain constancy of shape while growing. The exaggerated projecting teeth of some other mammals, such as the babiroussa (*Babyrousa babyrussa*) and the elephants (*Elephas maximus* and *Loxodonta africana*), are curved and may be true spirals (Dow and Hollenberg, 1977); the anomalous lower-jaw narwhal tusk reported by Mitchell and Kemper (1980) forms the first half-turn of a corkscrew spiral of 16 cm diameter.

We suggest that a sufficient explanation, and the only one needed, for the spiral in the narwhal's tusk is that it ensures that the tusk will grow straight overall (Fig. 1), even though the rate of growth does vary, as the surface irregularity shows, greatly around the root (Fig 2). That right and left tusks twist the same way is then the outcome of a 50:50 chance: a twist of either hand would serve equally well to keep the tusks symmetrically straight. No récherché asymmetry in swimming need be imagined; the narwhal doesn't corkscrew forward through the water, leaving its tusk in rotational arrears. The narwhal produces a massive display organ that it can tolerate in its aquatic existence, adapting a common phenomenon as a mode of production that can insure the straightness of the tusk axis against congenital or traumatic aberrations.

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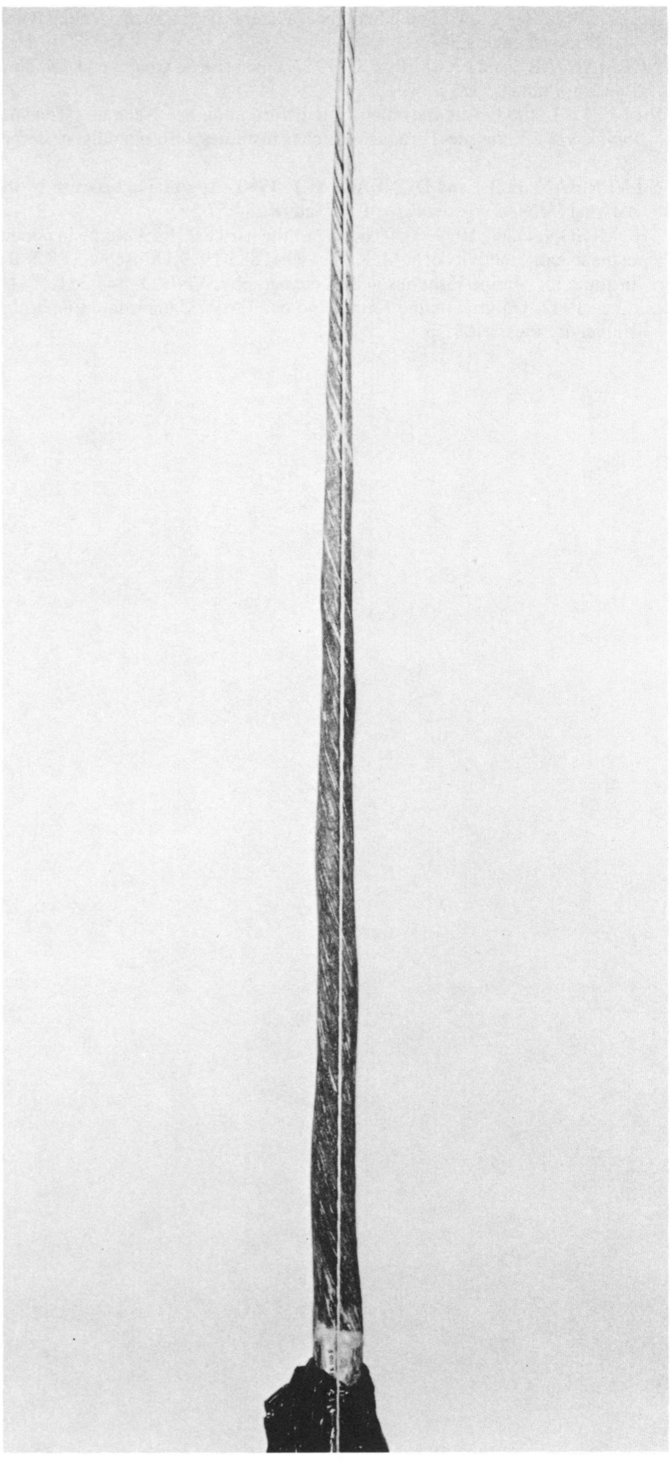

FIG. 1. Narwhal tusks are overall almost perfectly straight . . .

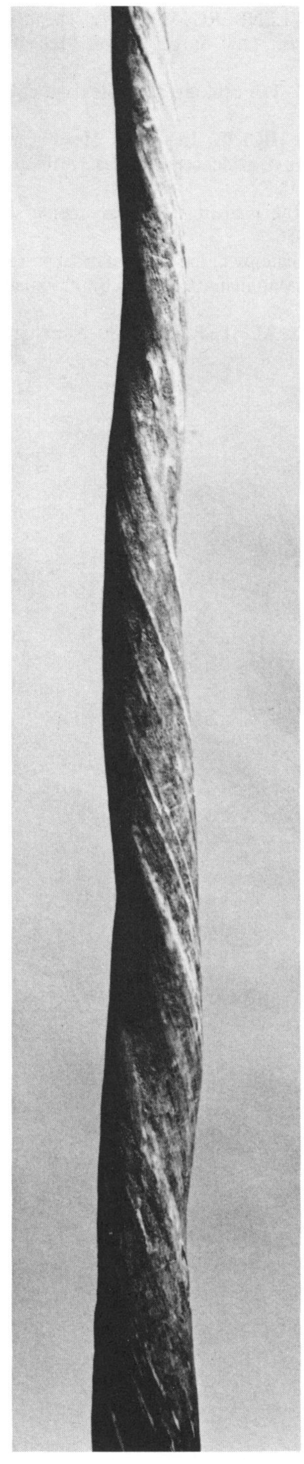

FIG. 2. . . . although they may grow irregularly on a smaller scale.

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