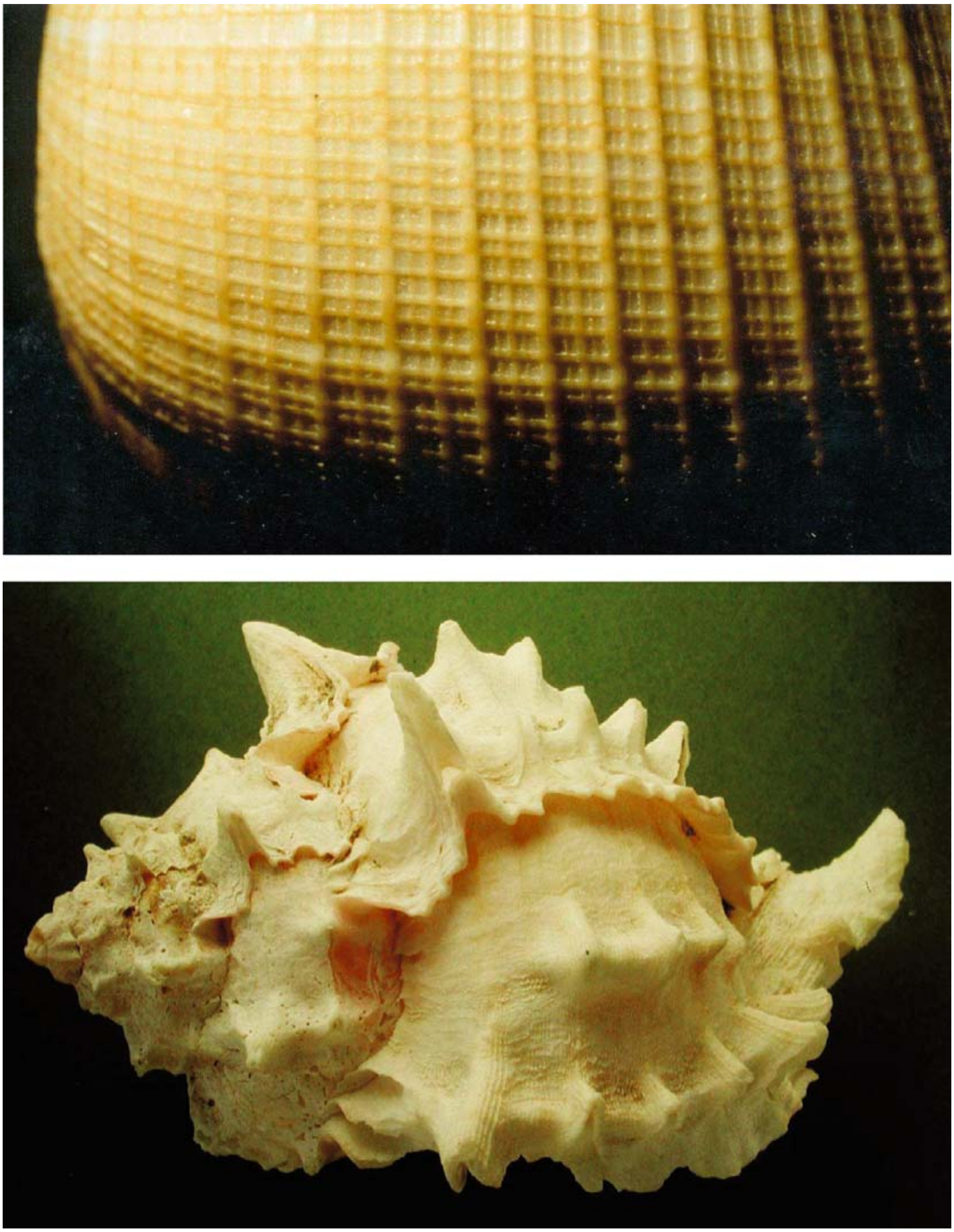

Figure 4.1. Superposition of two patterns, a periodic pattern in space that is stable in time and a periodic pattern in time that is spatially homogeneous. Top: *Ficus gracilis*; both patterns coexist without much interference. Bottom: *Bursa rubeta*. The pattern stable in time determines where, the oscillating pattern determines when the spines will be formed

Chapter 4

Superposition of stable and periodic patterns

A widely distributed subgroup of shell patterns result from the superposition of a stable and a periodic pattern. The upper shell in Figure 4.1 shows two sets of parallel relief-like lines. One set is oriented parallel to the growing edge and results from a thickening of the shell at periodic time intervals. The other set is oriented parallel to the direction of growth and results from a permanently enhanced deposition of shell material at regularly spaced positions. In this example, the two patterns do not interfere with each other, a situation that is more the exception than the rule, but it shows that the assumption of two superimposed systems is reasonable.

More intriguing are systems in which one system modifies the other. The bottom shell in Figure 4.1 shows spines that have been formed at regular time intervals in defined positions. Evidently, a stable pattern must exist that determines the position of the spines, and an oscillating pattern must decide the time at which spine formation actually occurs. Another regular substructure can also be recognized. Every second row is different from the intervening row. The first spine, counted from the shoulder, appears only in every second row and is much larger. After every second row a discontinuity in the shell is formed. Thus, with their combinatorial possibilities, superpositions of two (or more) patterns can provide a rich source of complexity.

This chapter will discuss patterns that result from the modulation of parameters in an oscillating system by a stationary pattern. Usually the modulating pattern is not directly visible but has to be inferred from the space-dependent behavior of the oscillating system. The diversity in patterns results from differences in the actual form of the stable pattern, from its action on the oscillatory system, as well as from the particular properties of the oscillating system. The following cases will be considered:

(i) The oscillation frequency is space-dependent resulting in a pattern of wavy lines.
(ii) Steady-state activations occur in some regions while in other regions the system oscillates. Fishbone-like patterns result.
(iii) Oscillations are restricted to particular regions, while in other regions they do not occur. The resulting pattern exhibits rows of dots or crescents.

H. Meinhardt, *The Algorithmic Beauty of Sea Shells*, 4th ed. The Virtual Laboratory,
DOI 10.1007/978-3-540-92142-4_4,