

## STUNTING IN INVERTEBRATES FROM THE TYPE AREA OF THE CASSIAN FORMATION (EARLY CARNIAN) OF THE DOLOMITES (ITALY)

Max Urlichs

With 2 Figures

Staatliches Museum für Naturkunde Stuttgart, Rosenstein 1, 70191 Stuttgart.

### Abstract

Stunting is described to occur in the bivalves *Palaeonucula strigilata* and *Prosoleptus lineatus*, the gastropod *Rhaphistomella radians*, and the brachiopods *Koninckina leonhardi* and *Camerothyris subangusta*, all from the Cassian Formation (Early Carnian, Dolomites). The high percentage of framboidal and finely dispersed pyrite in beds with stunting indicates reduced live conditions at the sea bottom. The occurrence of stunting correlates to the end of transgressive cycles, when stagnation took place at the end of the prograding of the neighbouring carbonate platforms in the St. Cassian Basin.

Key words: Stunting, bivalves, gastropods, brachiopods, Early Carnian, Dolomites.

### Introduction

The Cassian fauna is a well-known example of a dwarfed fauna in early literature. Recently, it was interpreted as stunted. However, dwarfism is defined as restricted to a genetically controlled small size of specimens, whereas stunting results from restricted ecological conditions (Hallam, 1965). In general, the bulk of the Cassian fauna is small-sized (Fürsich & Wendt, 1977), reinforced first of all by the abundance of juvenile specimens of bivalves, gastropods, ammonoids, and brachiopods. Furthermore, ecologically controlled extreme small size applies to some horizons (Fig. 1). These faunas are stunted because they contain small-sized adult specimens of elsewhere normal-sized species. However, a documentation of the stunting was not provided by the early authors cited in literature (summarized by Urlichs, 2004). To detect stunting, adult specimens from different beds were compared with each other. At the onset of maturity, the growth generally slows down rather than ceases. This leads to a crowding of the growth lines

in bivalves and brachiopods respective septa in ammonoids (Vogel, 1959).

Stunting was studied in detail only in ammonoids (merely in *Lobites*) and ostracods (Urlichs, 1971, 2004). The ammonoids *Lobites nautilus* (Münster) and *L. pisum* (Münster) are usually adult and completely preserved with their eccentric body chambers, hoods, contracted peristomes, and crowded sutures at the ends of the phragmocones. The septal spaces were measured on polished, exactly orientated sagittal sections and plotted against the number of septa (Urlichs, 2004, figs. 4, 6–11). Specimens from claystones and argillaceous marls have approximated sutures, beginning from the protoconch onwards, whereas specimens collected from marls have normal-spaced septa. Both have furthermore crowded sutures at the ends of the phragmocones and the same number of septa and whorls; thus they have the same individual age. The adult small-sized *Lo-*

*bites* specimens attain in average 69–72% of the diameter of normal-sized ones. Therefore, these small-sized specimens are genuinely stunted. The septal spaces were also measured on sagittal sections of several other ammonoids: *Joannites klipsteini* (Mojsisovics), *Lecanites glaucus* (Münster), *Megaphyllites jarbas* (Münster), *Proarcestes bicarinatus* (Münster), and *Trachyceras muensteri* (Wissmann). In contrast to *Lobites*, these species do not show differences of the septal spaces between the different horizons and have a septal spacing like in specimens from the coeval Hallstatt Limestone. Therefore, they are considered to be of normal size, and they are mostly represented by juvenile specimens with their body chambers and rarely by small nuclei. Adult specimens of the ostracods *Bairdia cassiana* (Reuss) and *Hungarella limbata* (Reuss) have equal sizes in the horizons with stunted and with normal-sized molluscs (Urlichs, 1971).

The material for this study was collected bed by bed in the type area of the Cassian Formation (GSSP Ladinian/Carnian: Broglio Loriga et al., 1999; Gaetani, 2009) southwest and south of St. Cassian (localities see Urlichs 2004, Fig. 1). The bulk of the faunas was found weathered out of the argillaceous or marl rocks. Collecting was very time-intensive because one had to rely on weathered out fossils, as only in this way large samples could be obtained.

### Fauna assemblages

Two different types of faunal assemblages are present in the type area of the Cassian Formation. Allochthonous faunas occur in few beds (Fig. 1: faunas 1a, 7, 11, 13a, 16b, 20 and 23). These faunas yield calcareous sponges and corals without attachment areas. Bivalves are univalved and often fragmented. Echinoids are more frequently represented by isolated spines than by ossicles. Crinoids are rare and only represented by isolated columnalia or at best by short stem fragments. The skeletal material of these assemblages was mainly transported by turbidites from the adjacent buildups and patch reefs from shallow areas into deeper water settings. The reef-dwelling bivalves, gastropods, and brachiopods are represented by quite other taxa than in the autochthonous faunas. Therefore, the allochthonous assemblages were discarded from investigating stunting.

The bulk of the Cassian faunas in the type area comes from autochthonous horizons from which two faunal associations, the *Rhaphistomella radians*/*Palaeonucula strigilata* association and the *Koninckina leonhardi* association, were already described by Fürsich & Wendt (1977). The first one is represented in the faunas 5, 6, 8, 9, 12, 13b, 14, 16a, 17, and 22, the second one in the faunas 10 and 15 (Fig. 1). A further association has a trophic nucleus composed of *Polygyrina lommeli* (Münster) and *Rhaphistomella radians* (Münster). It is represented in the faunas 1b–4. Another association, fauna 19, shows a predominance of *Koninckina leonhardi* (Wissmann), *Halobia fluxa* (Mojsisovics) and *Lobites nautilus* (Münster).

### Stunting

The aim of this study is to investigate the most common infaunal bivalves of the autochthonous deposits of the Cassian Formation, *Palaeonucula strigilata* (Goldfuss) and *Prosoleptus lineatus* (Goldfuss), the gastropod *Rhaphistomella radians* (Münster), and the brachiopods *Koninckina leonhardi* (Münster) and *Camerothyris subangusta* (Münster) whether stunting is present in these taxa or not (Figs. 2A–Q). Specimens of *Palaeonucula* which come from marls are obviously normal-sized when compared with Recent nuculids. The specimens from claystones and argillaceous marls are small-sized, but of the same shape. Comparing the lengths of adult specimens of *Palaeonucula strigilata* with crowded growth rings, the small-sized specimens attain only 45–55% of the normal-sized ones (Figs. 2A–C); hence, they are genuinely stunted. The growth rings in *Prosoleptus lineatus* are quite oblique. Therefore, the tiny concentric ribs were counted and the length at each tenth was measured. Adult small-sized specimens with approximated ribs have about the same number of ribs and thus have the same individual ages. They attain only 60–70% of the normal-sized ones. Therefore, these specimens are also stunted (Figs. 2D–F).

In *Rhaphistomella radians* (Figs. 2G–K), differences in size are striking, but these are smaller than in bivalves. Comparing the sizes of specimens from different beds, the diameter at the end of the fourth post-embryonal whorl was measured. Stunted specimens have a mean diameter which is 20–23% smaller than in normal-sized ones, and an about 10 degrees smaller apical angle.

The end-size of adult brachiopods *Koninckina leonhardi* and *Camerothyris subangusta* was investigated (Figs. 2L-Q). Comparing the widths of adult specimens, the small-sized specimens attain 71–79% of the normal-sized ones; hence they are also stunted.

Stunting was observed in the faunas 1b, 4, 8, 12, 22 and partly 19 (Fig. 1). The faunas 5, 6, 9, 10, 13b, 14, 15, 16a, 17, 18b, and partly 19 are normal-sized, whereas the faunas 2, 3, 18a are intermediate. The fauna 19 was obtained from an about 15 m thick sequence of marly and argillaceous beds alternating with limestones. All *Lobites* specimens from these beds are stunted. In contrast, two size classes of adult *Koninckina* specimens without transitions were found. The bigger specimens are normal-sized and the small-sized ones stunted when comparing them with the sizes of material from other horizons. The *Camerothyris* specimens are normal-sized in this fauna. Probably the stunted brachiopods and ammonoids come from different beds as the normal-sized brachiopods. Obviously, different faunas were mixed up during sampling.

## Conclusions

The stunted faunas have a reduced diversity, but they are still fully marine since stenohaline organisms like ammonoids and brittlestars are present. Therefore, low salinity cannot be the reason for the stunting in the Cassian Formation. The low diversity is an indicator of restricted live conditions. Furthermore, if one species is stunted, the whole population is concerned too. The normal-sized faunas occur in marls, whereas the stunted ones come from dark claystones and argillaceous marls which are rich in framboidal and finely dispersed pyrite (faunas 1, 4, 8, 12, 16a, 22 and partly 19). Possibly, the presence or abundance of certain cations such as Cu, Pb, Sn, and Ag may retard or stop the growth as in Recent invertebrates (Tasch, 1953: 428). However, special geochemical investigations do not exist for the Cassian Formation. The high pyrite content of some beds indicates a plausible reason for the stunting. Growth and development are retarded in Recent marine invertebrates by sulfoxide, an incompletely oxidized derivative of sulfhydryl occurring in the natural circuit (Tasch, 1953). Probably, during poorly oxygenated intervals in the Cassian Formation, the sulfhydryl was incompletely oxidized

to the toxic sulfoxide which was later precipitated as pyrite. These restricted live conditions characterized by stunted molluscs occurred at the end of transgressive cycles, when the St. Cassian Basin was narrowed and stagnation took place therein. This can be demonstrated in the Forcella di Settsass section. The surface of the Richthofen Reef is eroded and karstified (Cros, 1977, p. 341; De Zanche et al., 1993, p. 15). After the sea level high stand of the Cassian Dolomite 1 of the Richthofen Reef, this karstification indicates a low stand. During this time, the margins of the buildups were eroded. Sediments from the buildups like oncolites and fossils from the patch reefs were transported by turbidites into the St. Cassian Basin. Therefore, the karstified surface of the Richthofen Reef corresponds with an allochthonous fauna (here fauna 20) in the St. Cassian Basin. The slope of the Richthofen Reef is diachronously overlapped by deep water claystones lacking fossils (Bosellini, 1984, Fig. 17; Doglioni et al. 1990, Fig. 15). These beds are at first overlain by marly greenish-gray limestones with *Halobia fluxa* and rare ammonoids (fauna 21 on Fig. 1), then by argillaceous grey marls and dark clays. The frequent occurrence of *Halobia* indicates a deep neritic environment. The uppermost part of these beds bears a stunted fauna (fauna 22) with the predominance of the nuculids *Palaeonucula strigilata* and *P. expansa*. The sediment with framboidal and finely dispersed pyrite indicates a reduced environment and stagnation. These beds are then overlain by marls bearing a very diverse allochthonous faunal assemblage of shallow-water skeletal material (fauna 23). It indicates the next sea level low stand with erosion and karstification on the carbonate platforms.

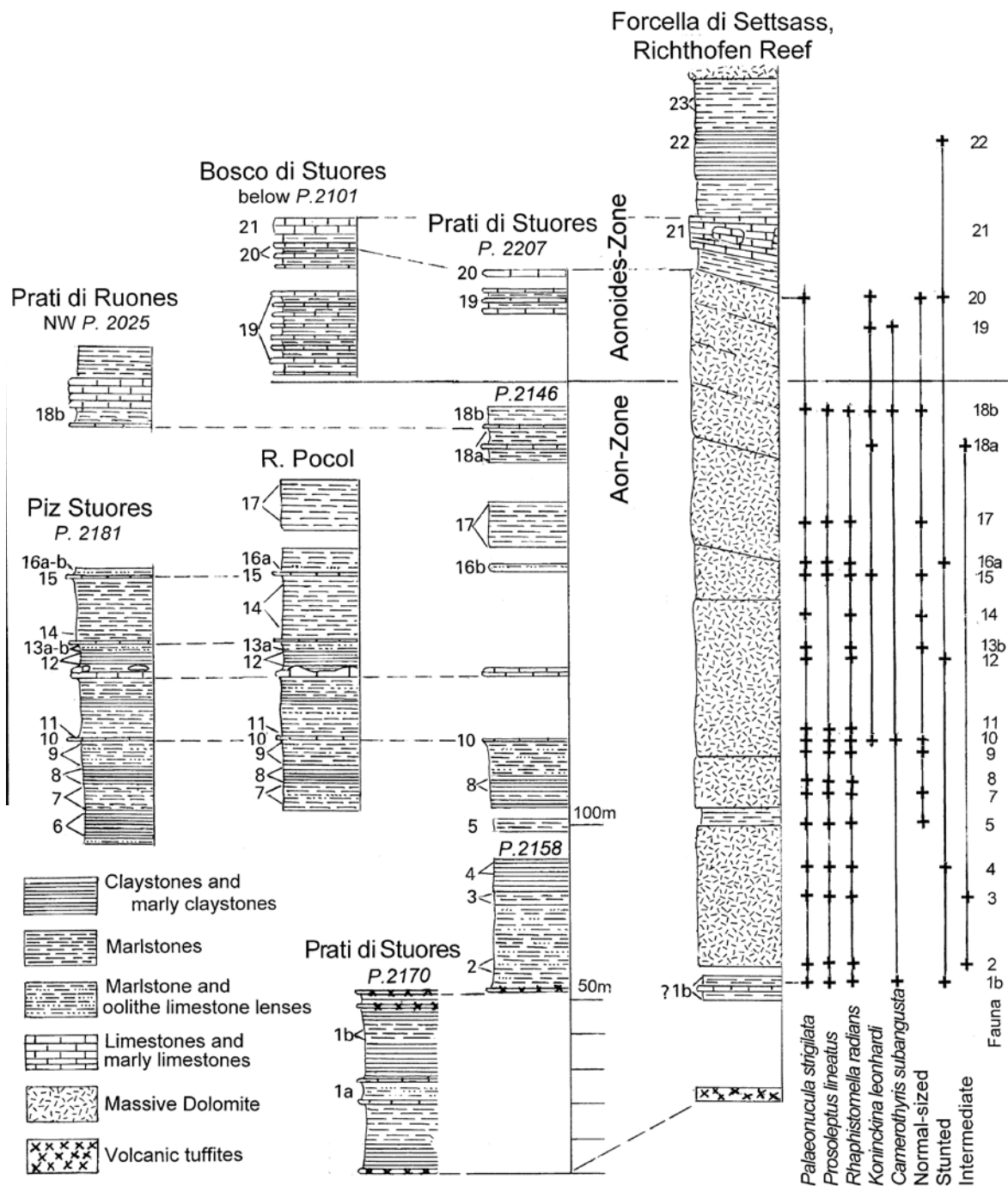


Fig. 1: Sections of the Cassian Formation in its type area south of St. Cassian (Dolomites, Italy), with the stratigraphical ranges of investigated species and occurrences of stunting (sections after Urlichs, 2004; for localities see Urlichs, 2004, Fig. 1).

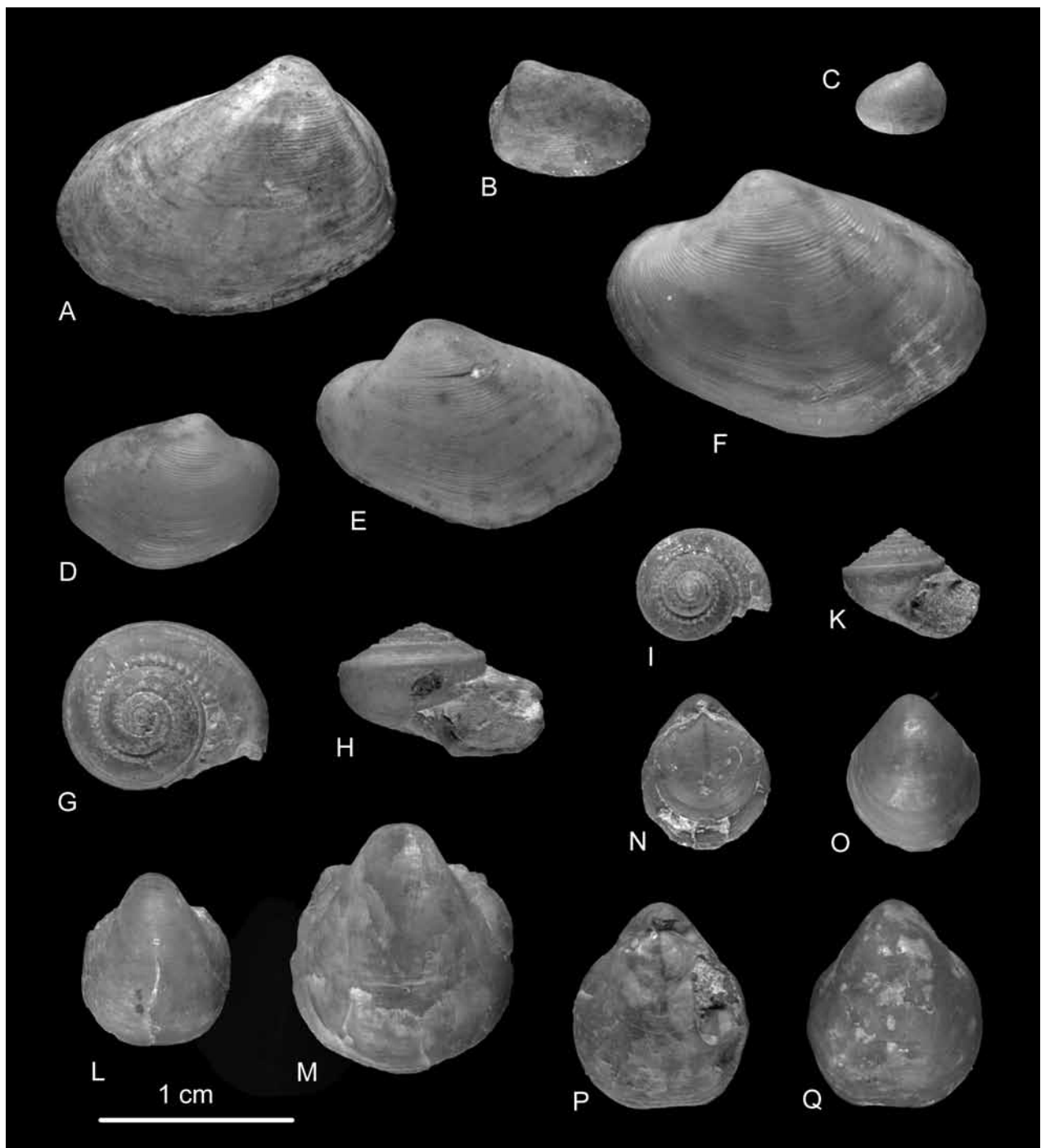


Fig. 2: Stunted and normal-sized adult specimens of the investigated species from the Cassian Formation.

Figs. A-C: *Palaeonucula strigilata* (Goldfuss), A: normal-sized, fauna 10, Piz Stuoers, B: stunted, fauna 1b, Prati di Stuoers, C: stunted, Fauna 22, Forcella di Settsass; Figs. D-F: *Prosoleptus lineatus* (Goldfuss), D: stunted, fauna 8, Rio Poccol, E: intermediate, fauna 9, Rio Poccol, F: normal-sized, fauna 17, Rio Poccol; Figs. G-K: *Rhaphistomella radians* (Münster), G-H: normal-sized, fauna 10, Piz Stuoers, I-K: stunted, fauna 12, Piz Stuoers; L-M: *Koninckina leonhardi* (Wissmann), L: stunted, fauna 19, Bosco di Stuoers, M: normal-sized, fauna 19, Prati di Stuoers; Figs. N-Q: *Camerothyris subangusta* (Münster), N-O: stunted, fauna 1b, below Richthofen Reef, P-Q: normal-sized, fauna 19, Rio Stuoers.



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