

Patterns of drilling predation of cassid gastropods preying on echinoids from the middle Miocene of Poland

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Test-drilling predation by cassid gastropods on minute clypeasteroid echinoids has been studied in the fossil assemblage of the *Heterostegina* Sands (middle Miocene, Holy Cross Mountains, Poland). The analysed prey, collected from two sublithofacies of the *Heterostegina* Sands (coarse-grained *Heterostegina* Sands and fine-grained *Heterostegina* Sands), represent three species of *Echinocyamus* (*E. linearis*, *E. pusillus* and *E. pseudopusillus*). The drill holes were produced presumably by one cassid species, *Semicassis miolaevigata*. The investigation showed that drilling predation intensities varied among the prey species. Within both fine- and coarse-grained sands, *E. linearis* was drilled more frequently than *E. pusillus*. An intermediate value of drilling predation was recognised for *E. pseudopusillus*. The intensities of drilling predation recognised for some of the prey species (*E. pusillus*) varied also between (but never within) the sublithofacies. Drilling predation was both size- and site-selective. Larger individuals of *E. linearis* and *E. pusillus* were attacked more frequently and the aboral side of the test of all *Echinocyamus* species was drilled preferentially. An extremely high concentration of drill holes was observed in the apical disc and petals. Results obtained for the most abundant prey (*E. linearis*) indicate that the predatory behaviour of large cassids was somewhat different from those typical of small cassids. Large cassids drilled and consumed their prey almost always individually, whereas small cassids sometimes preyed upon the urchins in a group. Large cassids displayed also a higher site-selectivity. They more frequently drilled in the petals and apical disc. The patterns of drilling predation were most likely controlled by the potential energetic value of prey (measured by the internal volume/test thickness ratio), prey and predator mobility, prey mode of life, thickness and porosity of the prey's tests, as well as by the proportions between the size of the prey and size of the predator. The results suggest that the mode of life of the prey and its test structure can influence the drill hole morphology.

Key words: Cassidae, echinoids, drill holes, drilling predation, predatory behaviour, middle Miocene, Poland.

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