

Gastropod shells cracked by hooded crows by dropping

Gerhard C. CADÉE

Royal Netherlands Institute for Sea Research, Postbus 59, NL 1790 AB Den Burg, The Netherlands;
cadee@nioz.nl

Bivalves and gastropods dropped by hooded crows (*Corvus corone cornix*) show - not surprisingly - a similar fragmentation as those dropped by herring gulls (*Larus argentatus*). Both bird species drop the shells from some height to crack them. Bivalves have one or both valves fragmented, but the valves still hold together by the ligament. Gastropods have either the spire broken off or a large hole in the body-whorl, sometimes also in the penultimate whorl. This hole is often opposite the aperture leaving the outer lip undamaged. Such large holes seem characteristic for shells dropped by birds. Stomatopods also make holes in shells but these are usually smaller.

Key words: Mollusca, Gastropoda, predation, shell-dropping, birds, Stomatopoda, Scotland, The Netherlands.

INTRODUCTION

Prey-dropping behaviour to break larger hard-shelled molluscs does occur among various bird species, particularly crows and gulls. Avian prey-dropping appears ideal to study foraging behaviour of these birds (Oldham, 1930; Tinbergen, 1941; Zach, 1978, 1979; Switzer & Cristol, 1999; Cristol & Switzer, 1999; Norris et al., 2000; Cadée, 2001; Lefebvre et al., 2002). It offers, moreover, possibilities to study whether the dropped shells are fractured in a characteristic way: can we identify broken shells as shells broken by avian shell-dropping? Are such fragments different from those produced by other molluscivores or by non-biological processes? This aspect is less studied in the past (e.g. by Zach, 1978), but from a palaeoecological point of view quite interesting, it may also enable to distinguish between mechanical and biological shell fragmentation (Cadée, 1968; Zuschin et al., 2003 and references therein). Palaeontologists became interested in the study of the evolution of predator/prey relationships based on lethal and sublethal (repaired) shell damage. Particularly Vermeij inspired numerous studies aimed at reconstructing the arms race between predators and prey during evolution (Vermeij et al., 1981; Vermeij, 1987; and for more references see Alexander & Dietl, 2003). This also makes recognising characteristic predator marks desirable. Finally, Teichert & Serventy (1947) and Cadée (1989) indicated the role played by shell-dropping birds in transporting shells away from the place where they lived. Molluscivorous marine diving birds cause comparable *ex-situ* transport of shells in shallow marine habitats (Lindberg & Kellogg, 1982).

A short stay on Skye (Inner Hebrides, Scotland) in the summer of 2003 offered an opportunity to observe shell-dropping hooded crows and study shells broken by shell-dropping. Earlier studies on shell-dropping by hooded crows were made by Berrow (1991) and Berrow et al. (1991, 1992). In the Netherlands hooded crows formerly were regular winter visitors, but they have become quite rare now. Hooded crows also used shell-dropping in the past in the Netherlands (see Tinbergen, 1950, citing a letter from P. de Bruyne, who observed this in the 1910s in the province of Zeeland). Nowadays in the

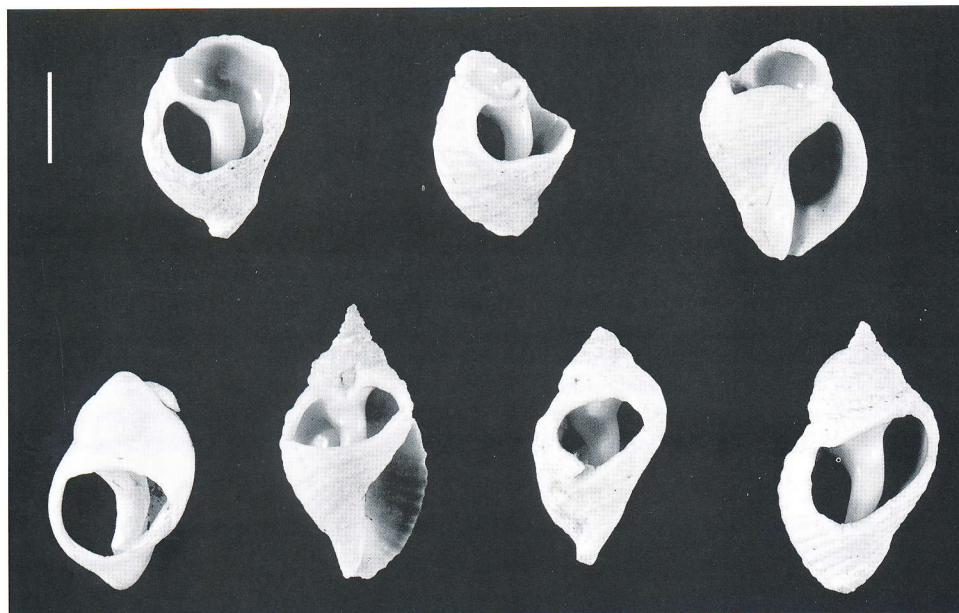


Plate 1. Shells of the dog whelk *Nucella lapillus* dropped by hooded crows (Broadford, Skye, June 2003).
Scale bar = 1 cm.

Netherlands we mainly observe shell-dropping by herring gulls (Tinbergen, 1941, 1953; Cadée, 1989, 1993, 1995a, 1995b, 2001, 2004).

OBSERVATIONS AND DISCUSSION

We observed hooded crows dropping shells during low tide on a pebbly intertidal area in front of Broadford (Skye) on 21–23 June 2003. The height from which the shells were dropped was estimated to be between 5 and 10 m. Among the shells dropped we collected mainly cockles *Cerastoderma edule* (Linnaeus, 1758) and mussels *Mytilus edulis* Linnaeus, 1758, but also a number of gastropods: whelks *Buccinum undatum* Linnaeus, 1758 and dog whelks *Nucella lapillus* (Linnaeus, 1758). 'Nature notes from Skye' (www.nature-diary.co.uk/2004-02-14.htm) shows a picture of shells dropped by hooded crows on a hill nearby, 40 m above sea level. They consisted of mussels (75%) and dog whelks (25%). The fragmented cockles and mussels we sampled at Broadford were not different from those dropped by herring gulls we collected in the Dutch Wadden Sea. Usually one valve is broken, sometimes both, but they are still held together with the ligament (Cadée, 1989, 1993, 1995a, 2001, 2004).

The dog whelks (*Nucella*) had either the spire broken off or a hole in the body-whorl opposite the side of the aperture. Our sample is small: four specimens had a hole, three the spire broken, the (strong) outer lip was still entire in all cases (plate 1). In the whelks (*Buccinum*) also the spire was broken off in four specimens and a hole was present in also another four specimens (plate 2). This hole was larger than in dog whelks and sometimes not only opened the body-whorl but also the penultimate. This may be due to the fact that

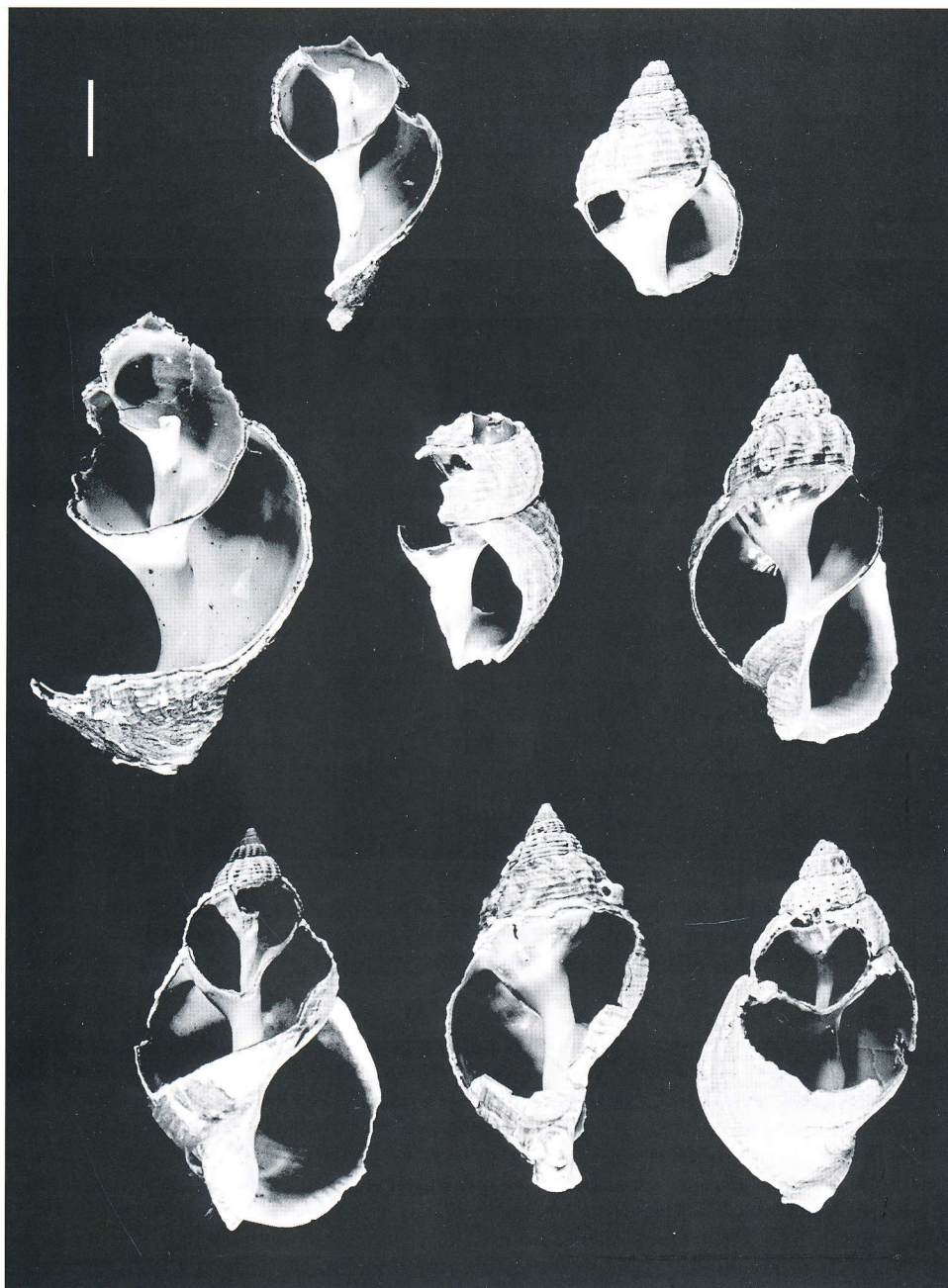


Plate 2. Shells of the whelk *Buccinum undatum* dropped by hooded crows (Broadford, Skye, June 2003).
Scale bar = 1 cm.

the shells of *Buccinum* are thinner where the fractures occur: 0.5 to 0.7 mm as compared with 0.9 to 1.4 mm in the *Nucella* specimens. This makes them more fragile. Zach (1978) observed a comparable fragmentation in another whelk *Thais lamellosa* (Gmelin, 1791). dropped by Northwestern crows *Corvus caurinus* in Canada. In his study of 90 freshly dropped whelks 76% had the spire broken off and 24% had a hole. Also in his case the outer lip remained intact. The presence of a hole in the outer whorl and the intact outer lip seem characteristic for gastropods fragmented by shell-dropping birds. This will be related to the way they hit the substratum on which they are dropped.

Whelks (*Buccinum undatum*) no longer occur in the Dutch Wadden Sea (Cadée et al., 1996). Whelks dropped by herring gulls along the Wadden Sea appeared to be old shells now inhabited by hermit crabs that were eaten by them (Cadée, 1995b). Also in these *Buccinum* shells, either the spire was broken, or a large hole was present in the body whorl, and the outer lip of the aperture was usually left intact. In this respect avian-dropped shells differ from shells consumed by crustaceans which open the shell by peeling, starting at the outer lip (Vermeij, 1978, 1987).

Other predators that produce holes in gastropod shells are e.g. stomatopods (mantis shrimps) (Caldwell & Dingle, 1976; Kohn, 1992; Pether, 1995; Baluk & Radwanski, 1996; Alexander & Dietl, 2003: fig. 8a). These holes are usually smaller than those produced by shell-dropping. Alexander & Dietl (2003) also mention 'shore birds' (no species named) that punch irregular holes in gastropod shells, the one pictured in their fig. 8b is less than 1 cm in diameter i.e. smaller than those caused by shell-dropping. Oystercatchers (*Haematopus ostralegus*) I observed feeding in the Wadden Sea on periwinkles [*Littorina littorea* (Linnaeus, 1758)] did not puncture the shells and apparently only consumed a small part of the gastropod, which they could take via the shell aperture.

In conclusion, large irregular holes may be characteristic in gastropod shells dropped by birds. If such shells are found on land or in terrestrial deposits, this is another clue to birds as the cause. But, as we noticed in Broadford, part of the shells are dropped during low tide in the intertidal and may remain in coastal marine deposits.

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