*BASTERIA, 68: 87-90*

# *Corbicula fluminea* (Müller, 1774) (Bivalvia, Corbiculidae) eaten by oystercatchers

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In this paper we report on oystercatchers feeding on *Corbicula fluminea*, a recent invader in the river Rhine. Oystercatchers are specialised molluscivores. They could reach these freshwater bivalves during low river level in the summer of 2003 and in the end of March 2004. The shell remains after consumption have a characteristic damage pattern: the valves still adhere by the ligament and only one of the valves has a (small) piece broken off ventrally. Due to lack of access, oystercatchers cannot use this food source on a regular base as they can with mussels and cockles in tidal areas exposed every low tide. Feeding irregularly on *Corbicula* shows the oystercatcher's flexibility in foodchoice.

Key words: Bivalvia, Corbiculidae, *Corbicula*, mass mortality, predators, shell-crushing, oystercatchers, Rhine, Netherlands.

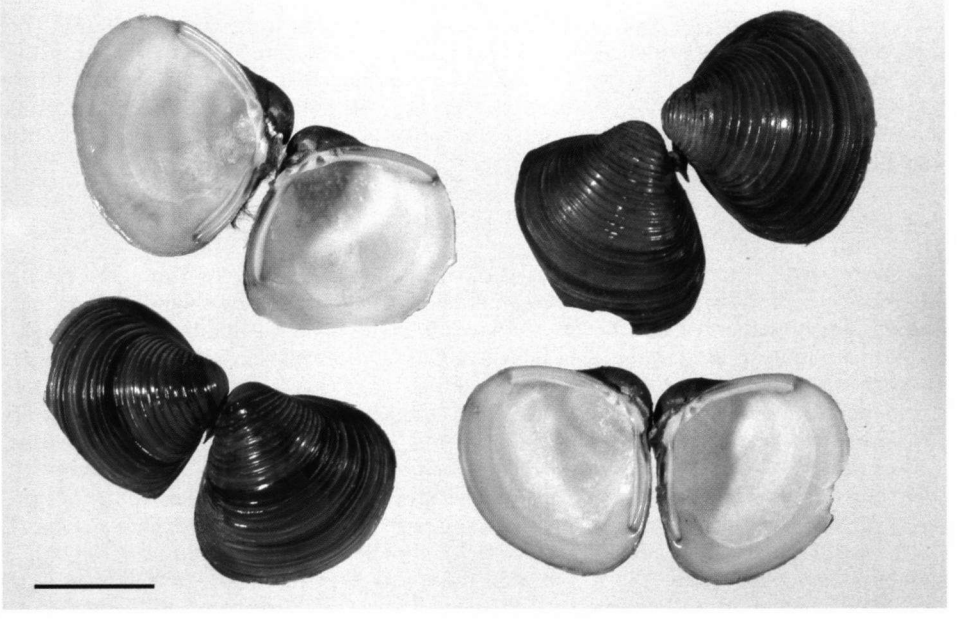

Fig. 1. Articulated shells of *Corbicula fluminea* broken by oystercatchers. Scale bar 1 cm.

## INTRODUCTION

*Corbicula* (*Corbicula*) *fluminea* (Müller, 1774) has invaded the Netherlands in the late 1980s (Bij de Vaate & Greijdanus-Klaas, 1990), and nowadays occurs in high densities in the different arms of the Rhine (Gittenberger & Janssen, 1998). The observation of thousands of entire articulated *Corbicula* specimens - *C. fluminea* and lower numbers of *C. fluminalis* (Müller, 1774) - beached along the river Rhine and particularly the Waal in 2003 called for explanations for their mass mortality and the apparently small importance of shell-crushing predators indicated by the still entire and articulated shells (Cadée, 2003, 2004a-b).

Oystercatchers (*Haematopus ostralegus*) are basically estuarine birds feeding during low tide on tidal flats. In the last century oystercatchers have extended their breeding area inland (Voous, 1960), where they mainly feed in grasslands on earthworms, leatherjackets (the larvae of crane-flies, *Tipula*), and caterpillars of moths (Hulscher, 1996). After breeding, most return to their favourite estuarine feeding areas such as the Wadden Sea (Van der Kam et al., 2003). Under favourable conditions, that is during low river levels, oystercatchers can also feed on freshwater bivalves such as the recently invaded *C. fluminea* as we show in this paper.

## OBSERVATIONS

On 20 March 2004, due to a gale the level of downwind corners of the river Rhine dropped sufficiently to enable oystercatchers to reach the *C. fluminea* living in the shallow parts of the Rhine near Wageningen. On this day the second author observed oystercatchers feeding on *C. fluminea* on a small beach along the Neder-Rijn near Wageningen. Nine specimens of *C. fluminea* were collected. One was actually observed being broken by an oystercatcher, the others were all surrounded by spoor of oystercatcher, showing they had been handled recently.

*Corbicula fluminea* shells consumed ranged in size (length) from 23.1 to 30.9 mm. The shell damage was characteristically always confined to one of the valves. In eight of the nine valves the damage was on the left valve. The sample is too small to base conclusions on this fact. The pictured specimens show the range of damage (fig. 1). The damage is small, at a maximum less than ¼ of one of the valves is removed. In four specimens only a small piece of the shell was broken off near the ventral margin.

## DISCUSSION

Oystercatchers are unique in their capability to open large bivalves using their strong bill. Some other birds have learned to fragment large shelled preys by shell-dropping, e.g. herring gulls (Switzer & Cristol, 1999; Cadée, 2001). The main feeding habitats of oystercatchers are in estuaries (Dare, 1966; Boates & Goss-Custard, 1992; Blomert et al., 1996). They have a large prey spectrum (Dare, 1966; Hulscher, 1996; Zwarts et al., 1996), but the staple food for the majority are estuarine bivalves such as cockles and mussels (Hulscher, 1996; Zwarts et al., 1996). The largest bivalve prey described is the giant bloody cockle *Senilia senilis* (L., 1758) (Swennen, 1990). These bivalves can reach sizes of up to 9 cm with a live mass of more than 500 g (which is of the same order as the body mass of an oystercatcher), exclusive of the shell mass which can reach up to over 400 g. Oystercatchers at the Banc d'Arguin needed sometimes up to 12 minutes to open this prey by 'stabbing'. 'Stabbing' is squeezing the bill in between the two valves to cut the adductor muscle between the valves. The alternative way to open bivalves is by 'hammering' (Tinbergen & Norton-Griffiths, 1964; Hulscher, 1996).

Depending on the opening method used, the specialised attacks of oystercatchers can leave characteristic fragmentation marks on the shells. In case of 'hammering' this results usually in a fragment broken only from one valve, which then remains attached to the unbroken valve by the ligament. This is described for cockles *Cerastoderma edule* (L., 1758) by e.g. Drinnan (1957) and Hancock & Urquhart (1965), for mussels *Mytilus edulis* L., 1758, by Dewar (1908, 1913; Tinbergen & Norton-Griffiths, 1964; Tinbergen, 1976; Cadée, 1994); and for the Baltic tellin *Macoma balthica* (L., 1758), by Hulscher (1982). When oystercatchers use the 'stabbing' technique, shells are left intact: the birds were able to insert their bill underwater between the gaping valves of a filter-feeding bivalve, and could sever the adductor muscle at once (for mussels see e.g. Northon-Griffiths, 1967).

Individual oystercatchers differ in the feeding technique they adopt; the suggestion is that they learn their feeding techniques and preferred prey types from their parents, but there is more flexibility than previously thought (Sutherland et al., 1996). Oystercatchers are able to learn to use new food sources: Swennen et al. (1985) described how some individuals specialised on feeding on a recent invader in the Wadden Sea, the bivalve *Ensis directus* (Conrad, 1843).

We report here on oystercatchers feeding on *C. fluminea*, a recent bivalve invader in the Rhine, which becomes available as prey during low water levels of the Rhine. B.S. Ebbinge (pers. comm., 2003) also has observed oystercatchers feeding on living *Corbicula* spec. during a period of low water levels in the summer of 2003. Cadée (2003) figured a damaged shell of *C. fluminea* collected near Wageningen along the Rhine, supposedly crushed by an oystercatcher. The damaged *C. fluminea* shell was very similar to *Macoma balthica* specimens damaged by oystercatchers as pictured in Hulscher (1982), and to damaged medium sized cockles as pictured by Drinnan (1957) and Hancock & Urquhart (1965): about halve of one of the still articulated valves is broken away by the oystercatcher to consume the shellfish. The specimens damaged by oystercatchers collected by Soes show considerably less damage. This casts some doubt whether the damage of the *C. fluminea* pictured in Cadée (2003) is really due to an oystercatcher; more material might solve this.

The huge quantities of empty but entire and articulated *C. fluminea* and *C. fluminalis* shells beached along the Rhine in the summer of 2003 were due to a mass mortality, related to a combination of factors: low river level, high temperature and probably low oxygen content; causes already mentioned by Gittenberger & Janssen (1998). *C. fluminea* in the Rhine has, however, also shell crushing predators such as fish (see e.g. Sindilariu & Freyhof, 2003 ). This could also be deduced from repaired shell damage in *C. fluminea*, indicating a failed predation attack as reported by Cadée (2003). Moreover, Cadée (2004b) published on diving ducks that crushed *C. fluminea* internally. We can add now oystercatchers, which crush *C. fluminea* externally by blows with their strong bill. H. Raad (pers. comm., 2003) gave a reaction on the paper by Cadée (2003). He had once observed a carrion crow (*Corvus corone*) feeding on an adult *Corbicula* near Rotterdam, the crow crushing the shell in a similar way as song trushes (*Turdus philomelos*) crush land snails.

## ACKNOWLEDGEMENTS

We are grateful to Dr B.S. Ebbinge (Alterra, Wageningen) for his observations on *Corbicula* consuming oystercatchers, to H. Raad for sending us his observation of a carrion crow crushing *Corbicula*, and to M.J.M. Poot for comments on an earlier draft of this paper.

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