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COYPU (*MYOCASTOR COYPUS* MOLINA, 1782) FEEDING ON ALGAE: FIRST EVIDENCE FOR EUROPE

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ABSTRACT. – In this note we report the first direct evidence for Europe of coypus (*Myocastor coypus*) feeding on freshwater algae. Coypus fed on green algae of the genus *Spirogyra* (Zygnematophyceae) in a Mediterranean coastal wetland of central Italy (Torre Flavia) where *Spirogyra* represents the most spread filamentous macroalgal stands. By analyzing *Spirogyra* stands, we also detected the presence of microalgae which, in turn, have been indirectly ingested by coypus: *Ulnaria capitata*, *Navicula* sp., *Nitzschia* sp. (Bacillariophyceae), *Netrium digitus* (Zygnematophyceae), and *Phacus* sp. (Euglenophyceae). Other taxa of green macroalgae, such as *Cladophora glomerata* and *Ulva intestinalis* (Ulvophyceae), were commonly recorded in the same area, however there is no evidence that they were consumed by coypus.

The coypu (*Myocastor coypus* Molina, 1782) is an aquatic mammal (Rodentia: Myocastoridae) native to South America which, over time, from the end of the 19th century, has been repeatedly imported into Europe, Asia, Africa and North America, for fur and meat markets (Cocchi & Riga 2001, Adhikari *et al*. 2022). Several populations of this herbivorous rodent, however, succeeded in establishing and persisting in the wild due to both multiple escapes from farms and human mediated releases, and they can currently be found in freshwaters and surrounding habitats (*e.g*., riverbanks, croplands). In Europe, North America and Asia, the coypu is an invasive species and is considered a pest because of its negative impact on biodiversity, ecosystems, and agriculture (Lowe *et al*. 2000, Bertolino *et al*. 2005, 2011, Randall & Foote 2005, Panzacchi *et al*. 2007).

Its herbivorous diet has been widely studied in several European countries (Abbas 1991, Llewellyn & Shaffer 1993, Johnson & Foote 1997, Carter & Leonard 2002), including Mediterranean wetlands (Prigioni *et al*. 2005, Reggiani 2008, Marini *et al*. 2013). In Louisiana wetland and Pampas region of Argentina populations, coypu's diet includes many angiosperm species, with a prevalence of hygrophilous monocotyledon species (Wilsey *et al*. 1991, Borgnia *et al*. 2000, Guichón *et al*. 2003) whereas, in this study population, the bulk of the diet is made of equal amounts of hygrophilous monocotyledon and terrestrial dicotyledon species (Marini *et al*. 2013). Any diet variation reported in this species occurs according to local environmental characteristics and to the growth cycle of the plant species available (see, for native ecosystems: Borgnia *et al*. 2000; for non-native translocation areas: *e.g*., Abbas 1991, Guichón *et al*. 2003, Towns *et al*. 2003, Prigioni *et al*. 2005, Marini *et al*. 2013). However, except in one study carried out in the wetland areas of Dorchester County (MD, USA, Willner *et al*. 1979), there is no evidence of feeding on algae. In this note, we reported coypus feeding on freshwater algae in a Mediterranean wetland of central Italy, as first evidence in Europe.

The study area is in Central Italy, within the "Torre Flavia wetland" Natural Monument (TFNM) (41°58'N; 12°03'E) a protected area on the Tyrrhenian coast (size: 40 ha; Special Protection Area, according to the EU Directive 79/409; Code IT6030020; Fig. 1).

TFNM is the remnant of a larger wetland that, in the second half of the 20th Century, was mostly drained and transformed into an agricultural and urbanized landscape (details in Talbi *et al*. 2020). Currently, TFNM still includes patches of semi-natural vegetation with a dominance of *Phragmites australis* reed beds, Mediterranean salt meadows (1420 – *Sarcocornetea fruticosae* EU Habitat type), rushbeds (1410 – *Juncetalia maritimi*, EU Habitat type with monocotyledons, such as *Juncus* spp., *Bolboschoenus maritimus, Carex* spp. and other Cyperaceae), back dunes (2110 – Embryonic shifting dunes EU Habitat type, 1210 – Annual vegetation of drift lines EU Habitat type), edge and synanthropic buffer habitats (Ceschin & Cancellieri 2006, Guidi 2006). Until 2004 TFNM was intensely managed for fish farming, mainly located in the reedbed core area (Marini *et al*. 2011). The area falls in the Meso-Mediterranean xeric region (Blasi 1994) and water supply comes largely from rainfall, with water stress occurring in late spring-late summer (Battisti *et al*. 2008, Causarano *et al*. 2009, Causarano & Battisti 2009, Zacchei *et al*. 2011).

Fig. 1. – Study area ('Torre Flavia' Natural monument; central Italy).

Fig. 2. – Two young coypus in a canal with *Spirogyra* macroalgal stands at Torre Flavia wetland (photo by S De Michelis).

Coypu presence has been detected in this area in 2004 (Battisti 2006) and the TFNM population has been intensively studied over the years since then (*e.g.*, Marini *et al*. 2011, Angelici *et al*. 2012, Grillo *et al*. 2020). This population is characterized by an oscillating demographic pattern, and it has been hypothesized that it might be a sink of a larger metapopulation in the region (Battisti *et al*. 2015). Marini *et al*. (2013) investigated its yearly diet, and split the flowering plants foraged into either rushbed or reedbed ecological categories.

As part of a wider project aimed at the control of this allochthonous invasive species (led by the public Agency managing the TFNM), from May to December 2021 a large set of data was collected on its ecology (population size, diet, parasites, use of shelters, rhythms of activity, habitat use, impact on the ecosystem, interspecific interactions). The diet was studied by direct observations (made at about 8-9 m from the animals, using Olympus 10 × 50 binoculars) and indirect observations by means of camera traps, sieving of fecal samples, and vegetational surveys. At each site where coypus were observed feeding on macroalgae, and only after the animals had left the site, samples of the dominant macroalgal stands were collected (50 ml tubes filled with water) and transferred to the laboratory for taxonomical analyses. Samples were then fixed using 2 ml Lugol and stored in refrigerator at 5° C. Examination and taxonomic identification of these samples were performed using an optical microscope (Zeiss Standard-25) and specific dichotomous keys (John *et al*. 2002) respectively. All identified species were then double-checked on the AlgaeBase website (Guiry & Guiry 2022) for possible taxonomic update whereas for

microalgae we carried out a comparison with the local checklist (Della Bella *et al*. 2006, see also Della Bella *et al*. 2007) to confirm either the presence of some species or report new ones locally.

During May 2021, we observed several times some individuals (at least four, both adult and juvenile ones) feeding on macroalgae in a canal. The macroalgae mainly consumed were green algae of the genus *Spirogyra* (Zygnematophyceae), the most extensive filamentous macroalgal stands in the area (Fig. 2). Coypu feeding behavior consisted in bringing the algae to the mouth with the front paws and cutting it with the incisors, while keeping the whole body but the head underwater. Even in deep waters, the coypus stayed still during feeding, being perfectly able to keep afloat without swimming (Evans 1970, Gosling 1979). In *Spirogyra* samples, several taxa of microalgae were recorded. Specifically, we identified diatoms (Bacillariophyceae), such as *Ulnaria capitata* (Ehrenberg) Compère, *Navicula* sp. and *Nitzschia* sp., one species of Zygnematophyceae, *Netrium digitus* (Brébisson ex Ralfs) Itzigsohn & Rothe, and one species of Euglenophyceae of the genus *Phacus*. Along the freshwater canals potentially frequented by coypus, we also detected additional filamentous macroalgae taxa, such as *Cladophora glomerata* (L.) Kützing and *Ulva intestinalis* L. (Ulvophyceae). Although their occurrence was recorded as common, there is no evidence of their consumption by coypus so far.

From an ecological perspective, most of the algae collected in the wetlands and canals of the study area belong to the typical assemblages inhabiting still or slowly flowing, moderately eutrophic waters as well as salty waters of coastal wetlands. In fact, many of these species, although mostly occurring in freshwaters, can also tolerate high salt concentrations such as *Ulva intestinalis* (John *et al*. 2002, Streble & Kauter 2002). In addition, these species are generally adapted to the abrupt changes in water level typical of these Mediterranean ecosystems.

Although opportunistic, these observations represent the first evidence of coypus feeding on algae in Europe, one out of two records ever reported in the literature (the other being wetland areas of Dorchester County, MD, USA, Willner *et al*. 1979). Further research at Torre Flavia wetland should plan both standardized observations to find out whether other species of macroalgae – available within the protected area – are included in coypu's diet and analyses focused on fine-grained variables, such as macroalgae availability and consumed biomass.

Currently, it is extremely difficult to carry out behavioral observations inside the wetland, both because of the poor visibility of many waterbodies due to reed cover (Ceschin & Cancellieri 2006), and because coypu elusiveness. Therefore, future diet studies at this site should mostly invest in other methodologies such as the analysis of either fecal or gastric samples.

The evidence brought by this study can contribute to a more complete knowledge of the feeding habits of this generalist and invasive allochthonous rodent, and consequently to a greater awareness of its impact on ecosystems, also providing additional tools for a proper management of the species outside its native range.

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