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Diet and feeding ecology of *Eriocheir sinensis* on the Polish coast of the Baltic Sea and in the Tagus Estuary, Portugal

by

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Abstract

The feeding ecology of the Chinese mitten crab *Eriocheir sinensis* was studied by analyzing the stomach fullness and its content with regard to sex, size and brackish water habitats occurring on the coast of the Baltic Sea (Gulf of Gdańsk and Vistula Lagoon, Poland) and the Atlantic (Tagus Estuary, Portugal). The presented results show that neither the site, sex (except the Gulf of Gdańsk) nor the size of an individual had a significant ($p > 0.05$) effect on the stomach fullness of *E. sinensis*. However, the type of food consumed was significantly ($p < 0.05$) correlated with the inhabited locality. The stomachs of crabs contained the remains of animal and plant origin, as well as detritus. The remains of animals (Bivalvia, Amphipoda, Gastropoda and Polychaeta) were more frequently found in the crabs from the Gulf of Gdańsk, while the remains of plants (Tracheophyta, Chlorophyta) were most often found in the stomachs of crabs from the Vistula Lagoon and the Tagus Estuary. Detritus was found only in the Gulf of Gdańsk and the Vistula Lagoon. Research indicates that the feeding ecology of omnivore *E. sinensis* is habitat specific, which should be taken into account when assessing the risk associated with this invasive species.

Key words: invasive species, Baltic Sea, Tagus Estuary, stomach content, Chinese mitten crab, Brachyura

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Introduction

Due to its negative impact on the biodiversity and ecosystem services, the Chinese mitten crab *Eriocheir sinensis* H. Milne-Edwards, 1853 is listed as one of the 100 World's Worst Invasive Alien Species (Lowe et al. 2000) and one of the invasive alien species of EU concern pursuant to Regulation (EU) No. 1143/2014 of the European Parliament and of the Council adopted in 2016 (EC 2016). Despite the fact that the mitten crab has been present in Europe for over 100 years, during which it has spread to 19 EU countries, little is known about its effect on biodiversity through trophic interactions (Panning 1938; Fladung 2000; Herborg et al. 2003; Czerniejewski et al. 2010; EC 2016). Moreover, this scant information, specific to certain regions only, is often used in the impact risk assessment for this invasive alien species in other areas. Bearing in mind that the crab diet depends on many biotic and abiotic factors, such a procedure may lead to erroneous conclusions. Therefore, more research on feeding ecology of this invasive species from different habitats is still required.

In general, the diet primarily depends on the quality, availability and usefulness of food to the consumer (Klekowski & Fischer 1993). The Chinese mitten crab is an opportunistic omnivorous species, which feeds continuously. As evidenced by many studies, however, its diet depends not only on food availability and habitat diversity, but may also vary with sex and size of specimens as well as season (Klekowski & Fisher 1993; Zhu et al. 1997; Fladung 2000; Jin & Xie 2001; Veldhuizen 2001; Jin et al. 2003). Being a brachyuran, *E. sinensis* cannot effectively hunt mobile prey, but it has massive claws that are used to cut aquatic plants and/or to crush shells of mollusks (Wójcik et al. 2015).

Results of previous studies showed that individuals of *E. sinensis* from the native region (latitude range: 24–42°N) are more carnivorous and prefer benthic invertebrates (Thiel 1938; Halat & Resh 1996; Zhu et al. 1997), while those from e.g. the Oder River/Oder Estuary and German rivers feed mainly on macrophytes and vascular plants (Fladung 2000; Czerniejewski et al. 2010), and those from San Francisco Bay – on plants and detritus (Rudnick & Resh 2005; Rogers 2000). However, Rudnick et al. (2000) concluded that feeding habits of *E. sinensis* are dominated by detritivory.

Even though *E. sinensis* is a catadromous species and occurs in large numbers in brackish waters, like estuaries, lagoons and bays (Veilleux & de Lafontaine 2007), there is still little information on its diet in these types of habitats. It is worth mentioning that this species has not been capable of establishing its populations in all brackish waters. For example, the salinity in the Gulf of Gdańsk and in the Vistula Lagoon (Baltic Sea coast, Poland) is too low (7 and 0.5–2.5, respectively; Kruk-Dowgiałło & Szaniawska 2008; Kruk et al. 2011) to support the complete larval development of this species (Anger 1991; Czerniejewski & Wawrzyniak 2006; Wójcik-Fudalewska & Normant-Saremba 2016). For this reason, no stable population exists in the above-mentioned regions and only adult crabs are found there, which are likely to have migrated from Germany, where they have a large population established. On the other hand, an established population of *E. sinensis* has been recorded in the Tagus Estuary (Cabral & Costa 1999; Wójcik et al. 2014; Anastácio et al. 2018), which empties into the Atlantic Ocean in Portugal (salinity of 0–8 at the head of the estuary; Ferreira et al. 2003, Anastácio et al. 2018).

This study analyzed the feeding ecology of *E. sinensis* in brackish habitats with different environmental conditions, occurring on the costs of the Baltic Sea (Gulf of Gdańsk and Vistula Lagoon, Poland) and the Atlantic (Tagus Estuary, Portugal), in relation to the size or sex of specimens. On this basis, it will be possible to determine which organisms may be affected by *E. sinensis* through trophic interactions. The acquired knowledge is therefore not only of cognitive, but also of practical importance, as it may help to assess the risk associated with the presence of the Chinese mitten crab in the Polish and Portuguese waters.

Materials and methods

In Poland, *Eriocheir sinensis* specimens were collected in the Gulf of Gdańsk in May–December 2005 and April–December 2006, and in the Vistula Lagoon in March–November in 2011–2015. In Portugal, crabs were collected in September 2013. In all cases, crabs were collected from fyke nets in cooperation with local fishermen (Fig. 1). Specimens collected in Poland were immediately frozen at –20°C to cease digestion, whereas in the case of crabs collected in the Tagus Estuary, 10% formalin was injected into the stomachs immediately after collection. In order to identify the crabs, they were sexed on the basis of their abdominal structure (Schäferna 1935) and the width of their carapaces was measured (± 0.1 mm). The carapace width was expressed as a mean and standard deviation (mean ± SD).

In the laboratory, the stomach of every specimen was dissected and analyzed under a stereomicroscope

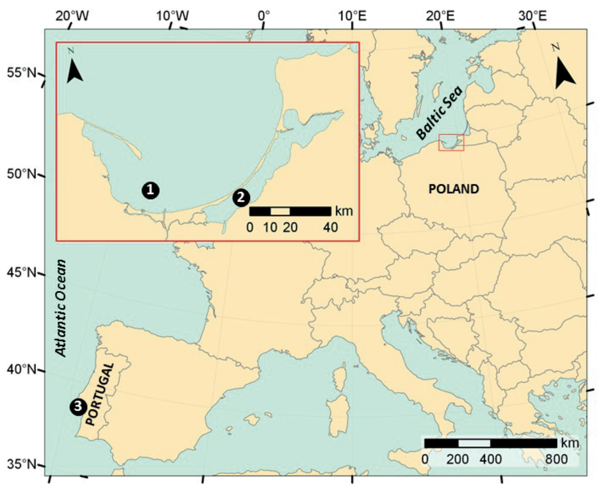

Figure 1

Sampling sites: (1) the Gulf of Gdańsk, (2) the Vistula Lagoon and (3) the Tagus Estuary (geographic data source: ESRI)

at 1–6.3 × magnification in order to assess its fullness according to two categories: empty and filled. Afterwards, food remains found inside of each filled stomach were analyzed and classified into one of the following categories: (1) of plant origin, (2) of animal origin, and (3) detritus. In some cases, the identification was not possible due to the advanced stage of digestion. Plant and animal remains were then identified to the most accurate taxonomic level based on the characters provided by Pliński (1980), Żmudziński (1990), Barnes (1994) and Hayward & Ryland (1995).

To compare the size structure between individuals with filled and empty stomachs, crabs were divided into three carapace width classes, starting at 20.0 mm (every 23.5 mm). Differences in the studied variables between groups of crabs were tested using the Mann–Whitney U-test, the Chi square test or the Wilcoxon matched pair test at the 95% significance level. The difference in the independent proportions was tested using the two-proportion test at the 95% significance level. The normality of the data was tested using the Shapiro–Wilk test at a significance level of 95%. The analyses were carried out using STATISTICA 12.0 (StatSoft, Poland).

Results

Specimen characteristics

In total, 49 individuals were obtained from the Gulf of Gdańsk, 200 from the Vistula Lagoon and 38 from the Tagus Estuary. Their sex and size characteristics are presented in Table 1.

Stomach fullness

At each location, both crabs with empty and filled stomachs occurred, with the latter group dominating (Fig. 2). The differences in the proportion of individuals with empty and filled stomachs were statistically significant (two-proportion test; $p < 0.05$) at each site.

While the proportions of females ($p = 0.65$) and males ($p = 1$) with filled stomachs were significantly different (two-proportion test; $p < 0.05$) in the Gulf of Gdańsk, no such differences were found ($p > 0.05$) in the Vistula Lagoon ($p = 0.88$ for females and $p = 0.80$ for males) and in the Tagus Estuary ($p = 0.86$ for females and $p = 0.88$ for males).

Except for the smallest carapace width class (20.0–43.5 mm; n = 3) from the Vistula Lagoon, crabs

Table 1

The number of individuals and carapace width (mean ± SD) of *E. sinensis* females and males collected from the Gulf of Gdańsk, the Vistula Lagoon and the Tagus Estuary. The same letters indicate no significant differences (Wilcoxon matched pair test; $p > 0.05$)

Site	Number of individuals	Carapace width (mm)	
		Average	Range
Gulf of Gdansk	49	62.00 ±7.80	43.00–82.00
Females	20	61.26 ± 7.90[a]	46.90–82.00
Males	29	62.29 ± 7.75[a]	43.00–78.60
Vistula Lagoon	200	66.77 ± 8.38	33.26–89.07
Females	89	67.04 ± 6.38[b]	53.70–81.49
Males	111	66.56 ± 9.22[b]	33.26–89.07
Tagus Estuary	38	44.35 ± 6.27	20.63–56.42
Females	21	43.88 ± 7.29[c]	20.63–44.53
Males	17	44.93 ± 4.87[c]	37.83–56.42

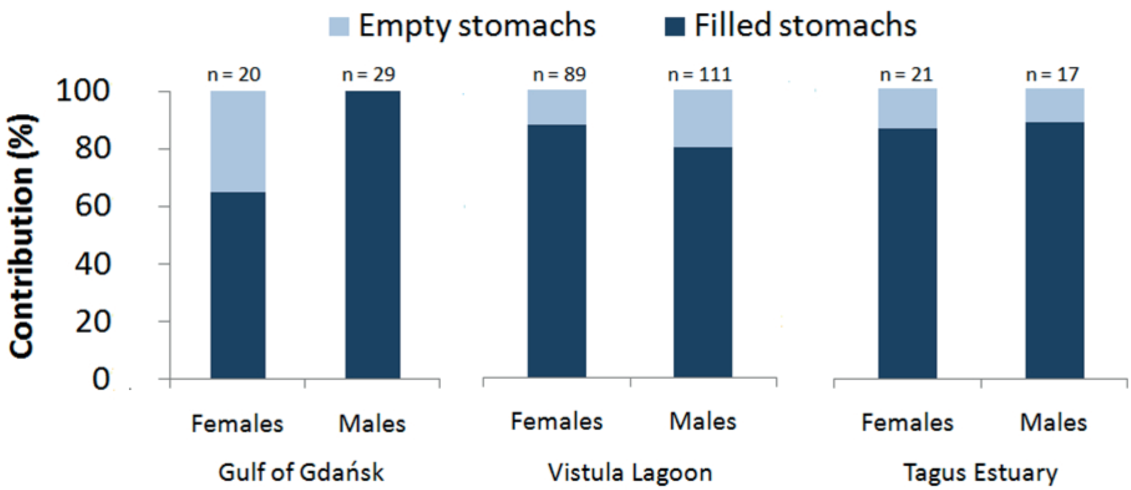

Figure 2

Percentage of individuals with filled and empty stomachs from the Gulf of Gdańsk, the Vistula Lagoon and the Tagus Estuary

with filled stomachs dominated (80% and above) among all size classes at all locations. The carapace width of specimens had no significant effect on the stomach fullness in any of these locations (Chi square test; $p > 0.05$).

Diversity of food remains

Stomachs of crabs from the Gulf of Gdańsk and the Vistula Lagoon contained remains of all three categories, i.e. of animal and plant origin, as well as detritus (Table 2, Fig. 3). Individuals from the Tagus Estuary contained only remains of animal and plant origin (Table 2, Fig. 3). Animal remains were more frequently found in the crabs from the Gulf of Gdańsk – they were found in 55% of females and 69% of males with filled stomachs (Fig. 3). On the other hand, plant remains were most frequently found in stomachs of crabs from the Vistula Lagoon and from the Tagus Estuary. They accounted for 81 and 85% of females and males (respectively) in the former reservoir, and 54 and 88% (respectively) in the latter.

Significant differences in the proportions of individuals with different types of food remains were found for all locations (two-proportion test, $p < 0.05$), except for the proportion of individuals with plant remains ($p = 0.12$) and detritus ($p = 0.10$) in the Gulf of Gdańsk ($p > 0.05$).

Table 2

The number of specimens with different food remains in their stomachs collected in the Gulf of Gdańsk, the Vistula Lagoon and the Tagus Estuary. Not all remains were taxonomically identified (ni – not identified)

	Gulf of Gdańsk	Vistula Lagoon	Tagus Estuary
Plant origin	6	133	33
Chlorophyta	6	16	ni
Tracheophyta	0	50	ni
No taxonomic identification	0	67	33
Animal origin	25	57	13
Crustacea	4	1	ni
Bivalvia	16	29	ni
Amphipoda	3	2	ni
Gastropoda	2	1	ni
Polychaeta	0	5	ni
No taxonomic identification	0	16	13
Detritus	5	28	0

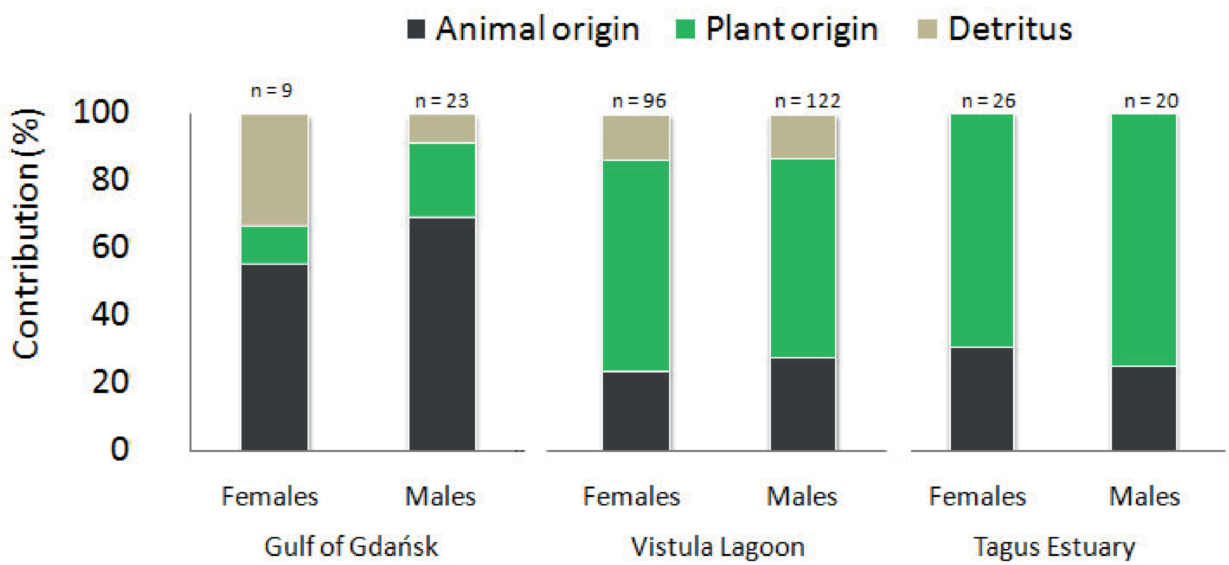

Figure 3

Percentage of females and males from the Gulf of Gdańsk, the Vistula Lagoon and the Tagus Estuary with stomachs containing different categories of food remains. Specimens with empty stomachs are not included; n indicates the number of specimens with filled stomachs (a single crab can contain remains belonging to different categories)

In the Gulf of Gdańsk, the proportion of females and males with animal remains (p = 0.56 and 0.69, respectively), plant remains (p = 0.11 and 0.22, respectively) and detritus (p = 0.33 and 0.08, respectively) in their stomachs did not differ significantly (two-proportion test; $p > 0.05$). Similarly, there were no significant differences (two-proportion test; $p > 0.05$) in the Vistula Lagoon between females and males with stomachs filled with animal remains ($p = 0.24$ and 0.28, respectively), plant remains ($p = 0.63$ and 0.59, respectively) and detritus ($p = 0.14$ and 0.13, respectively). Furthermore, no significant differences (two-proportion test; $p > 0.05$) were found between females and males coming from the Tagus Estuary and with stomachs filled with animal remains ($p = 0.31$ and 0.25, respectively) and plant remains ($p = 0.70$ and 0.75, respectively).

In all locations, the proportion of individuals with diverse types of food remains did not differ significantly between carapace width classes (two-proportion test; $p > 0.05$).

The most common remains of animal origin found in the stomachs of crabs from the Gulf of Gdańsk and the Vistula Lagoon were shells of bivalves, i.e. *Mytilus trossulus* and *Dreissena polymorpha*, respectively (Table 2). At both sites, fragments of carapaces and appendices of *Gammarus* spp., shells of *Cerastoderma glaucum* and Hydrobiidae as well as fragments of *Amphibalanus improvisus* were also found (Table 2). In the Tagus Estuary, the accurate taxonomic analysis was not possible, because the remains of animals were very shredded. Crushed shells were also observed, but their taxonomic identification was impossible. This is related to the climate of the estuary and high temperatures that cause faster digestion. In the Gulf of Gdańsk and the Vistula Lagoon, Chlorophyta and Tracheophyta were identified among the remains of plant origin (based on green color and vascular structure, respectively), whereas only the latter group was found in the Tagus Estuary.

Discussion

Stomach fullness

Feeding frequency (established on the basis of stomach fullness) is a species trait, determined also by the sex of a given individual (Mantelatto & Christofoletii 2001). The results of the research show that *E. sinensis* feeds continuously, which is typical of many crab species, for example the mangrove swimming crab *Thalamita crenata*, the Japanese mitten crab *Eriocheir japonica* and *Plagusia dentipes* (Cannicci et al. 1996; Samson et al. 2007; Kobayashi 2009). More than 80% of individuals from each of the surveyed regions had their stomach filled. *E. sinensis* is an omnivore that feeds not only on the most available types of food, but also on food with varied biochemical composition, calorific value and bioavailability (Dittel & Epifanio 2009). However, the duration of the digestion process is affected not only by the quality and quantity of food, but also by the season, time of the day, changes in salinity, temperature, oxygen levels, as well as the age and condition of a given individual (Ceccaldi 1989; McGaw & Curtis 2013). Depending on the type of food consumed, this process in crabs lasts from 4 to 38 h (McGaw & Curtis 2013). Soft food (e.g. fish or mollusk flesh) is most quickly removed from the stomach (4–6 h), while mineralized food such as fragments of mollusk shells or fish bones may stay in the stomach for up to 120 h (Kneib & Weeks 1990; McGaw & Curtis 2013).

It should be taken into account that an empty stomach can mean both the complete digestion of food consumed or lack of feeding in the period preceding the collection of crabs. On the other hand, the absence of feeding before the sampling may result from the poor availability or (less likely) lack of food in the environment, which may be associated with the specificity of a water body or strong competition for food. The lack of feeding may also be a result of e.g. molting and copulation, incubation of eggs by females or stress caused by e.g. pain or changes in environmental conditions (Williams 1982; Norman & Jones 1992; Freie 1996; Elwood 2012). It should also be considered that the analyzed specimens were collected from fishing nets, where they could digest the food consumed earlier or could have no access to food. The dominance of specimens with full stomachs leads to the conclusion that the species has good access to food at all sampling sites.

The sex of an individual has no effect on the stomach fullness in *E. sinensis*, despite the fact that the prey choice is often a function of sexual dimorphism (morphology and size of claws) and differences in foraging behavior (Spooner et al. 2007). Based on the stomach fullness, it may be concluded that the foraging frequency is similar for both sexes. As in the case of *E. sinensis*, the sex has no effect on the feeding ecology in other Decapoda, e.g. the Norway lobster *Nephrops norvegicus* from the Mediterranean and the Atlantic (Cristo & Cartes 1998), the swamp ghost crab *Ucides cordatus cordatus* from Brazil (Nordhaus 2004) and the Harris mud crab *Rhithropanopeus harrisii* from the Gulf of Gdańsk (Hegele-Drywa & Normant 2009).

The results also indicate that the size of *E. sinensis* individuals has no effect on the foraging frequency. According to the literature, however, smaller specimens often crush their food, which facilitates the digestion. Large individuals, which are more capable of obtaining food, do not eat frequently, because they still have sufficient energy reserves (Kidawa et al. 2004), whereas smaller, younger specimens have a faster metabolism and consumption rate compared to larger (older) individuals, so that the food is digested faster (Bridges & Brand 1980; Schmidt-Nielsen 1997; Łapucki et al. 2005). Rogers (2000) also observed no effect of the size of *E. sinensis* individuals on the stomach fullness, unlike Freire (1996) who reported that the size of the harbor crab *Liocarcinus depurator* affects the stomach fullness.

Diversity of food remains

The results confirm that, similarly to other water bodies, *E. sinensis* is an omnivorous species in the Gulf of Gdańsk, the Vistula Lagoon and the Tagus Estuary, and its diet consists of plants, animals and detritus (except for the Tagus Estuary). The lack of a strictly defined diet enables the organism to provide all elements needed for the growth and development, as for example food of plant origin provides important nutrients, whereas food of animal origin provides necessary proteins and fats (O'Brien 1994; Takeushi & Murakami 2007).

The results of the study show that the proportion of particular types of food in the diet of this species varies depending on the place of their occurrence. Food of animal origin dominates in individuals from the Gulf of Gdańsk, while those from the Vistula Lagoon and the Tagus Estuary consume mainly plants. *E. sinensis* feeds on sessile mussels, like the native blue mussel *M. trossulus* or the non-native zebra mussel *D. polymorpha* whose shells can be easily crushed with massive claws (Wójcik et al. 2015). In the Vistula Lagoon, another species of bivalves *Rangia cuneata* also occurs, which was very abundant in 2011–2015, but it is possible that we did not find any shell of *R. cuneata,* because *E. sinensis* individuals feed only on mussel flesh, which was digested immediately after consumption. Interestingly, *C. glaucum* does not live in the Vistula Lagoon, but it is possible that parts of shells stay in the stomach of *E. sinensis* after its migration from the Gulf of Gdańsk. Fragments of *A. improvisus* calcareous shells were always found together with the remains of *M. trossulus*, which is often overgrown by the former. The obtained results are similar to those obtained by Soes et al. (2007), who found that *E. sinensis* feeds on fauna characterized by low mobility, such as bivalves and snails. Their inorganic shells stay longer in the stomach, which makes it easier to conclude about the food consumed by

Decapods (Parslow-Williams et al. 2002; Hegele-Drywa & Normant 2009). Bones and fragments of fish spines were found in the stomachs of *E. sinensis*, but they were not abundant. They probably came from fish that had already been caught in the same nets as the crabs and then eaten by the latter. Fish bones were also found in the stomachs of *E. sinensis* from other regions (Peters & Panning 1933; Thiel 1938; Rogers 2000). It is also unlikely that *E. sinensis* is able to hunt crustaceans from the genus *Gammarus*, which were rather consumed dead or accidentally with plants and/or bivalves while hiding among their shells. *E. sinensis* can easily find sick or dead individuals, probably due to a well-developed sense of chemoreception (Webster et al. 2015). Notwithstanding the fact that crabs in general have well-developed olfactory senses, the strength of the food signal may also be a significant factor modifying the foraging behavior (Weissburg & Zimmer-Faust 1993, Aarnio et al. 2015). Peters & Panning (1933), Thiel (1938), Rogers (2000), Jin et al. (2003) found also crayfish, insects, Bryozoa, freshwater polyps and various worm larvae in the stomachs of *E. sinensis* living in freshwater, which we did not find during our research. This may be due to the fact that the examined organisms occur in other places, but often also due to the excessively digested remains, which prevents accurate taxonomic identification. The absence of *Chironomus* larvae is also surprising as they are very abundant in the benthos of the Vistula Lagoon. They were probably digested soon after consumption. *E. sinensis* was collected from the nets twice or three times a week, so it is possible that part of the consumed food was digested before the stomach content was analyzed. Crabs from the Gulf of Gdańsk forage mainly for food of animal origin, probably due to the fact that the availability (diversity) of this type of food is much higher in these waters compared to the Vistula Lagoon. *R. harrisii* from the Gulf of Gdańsk also feeds more frequently on the food of animal origin, because it is more available in the region, both in terms of quantity and quality (Hegele-Drywa & Normant 2009).

The diet of specimens from the Vistula Lagoon and the Tagus Estuary was dominated by food of plant origin. A high proportion of plant remains was also found in *E. sinensis* specimens from German waters (Thiel 1938) and San Francisco Bay (Halat 1997; Rogers 2000; Rudnick et al. 2000). Research conducted earlier in the Tagus Estuary also showed a significant dominance of fragments of plant origin (Anastácio, personal comm.). On the other hand, the percentage of plant matter in the diet of adult Chinese mitten crabs from the Oder Estuary (Poland) was much smaller than that of detritus and did not exceed 11% (Czerniejewski et al. 2010). Unfortunately, due to the high fragmentation of food remains, it was not possible to determine which species of vascular plants are included in the diet of *E. sinensis* from the surveyed water bodies. Nonetheless, according to the information provided in the literature, *E. sinensis* from German and North American waters feed on vascular plants from the genera *Potamogeton*, *Elodea* and *Lemna* (Veldhuizen & Stanish 1999).

In the Tagus Estuary, characterized by unstable physicochemical parameters of the environment, the diversity of invertebrate fauna, i.e. the food of *E. sinensis*, is low (Hodgkin & Lenanton 1981). Furthermore, the dominance of plant matter in the diet of *E. sinensis* from the Tagus Estuary may be associated with the presence of smaller (young) individuals, which grow and thus molt more often and, consequently, have a greater demand for minerals (Takahashi & Kawaguchi 2001; Turra & Denadai 2003; Aarnio et al. 2015). The dominance of plant matter in the stomachs of specimens from the Vistula Lagoon and the Tagus Estuary may also result from its higher availability in these relatively shallow and brackish water bodies (Dias et al. 2013; Rychter et al. 2018; Witak & Pędziński 2018). In the Tagus Estuary, the choice of plants as food may also be influenced by the competition for the most energetic food with other Decapoda, e.g. *Carcinus maenas*, the red swamp crayfish *Procambarus clarkii* in the upper estuary, the common prawn *Palaemon serratus* or *P. longirostris* (Dias & Marques 1999; Banha & Anastácio 2011).

Interestingly, organic matter is an important contribution to the diet of *E. sinensis* in many regions (Rogers 2000; Czerniejewski et al. 2010). Detritus is most often consumed in winter and by females incubating eggs, buried in bottom sediments (Veilleux & de Lafontaine 2007). In this study, detritus was consumed by crabs from the Gulf of Gdańsk and the Vistula Lagoon. Detritus found in the stomachs has always accompanied other food remains, i.e. of plant and animal origin, as it is likely an additional source of energy (easily accessible at the bottom of a water body). No detritus was found in the stomachs of *E. sinensis* from the Tagus Estuary, which may indicate sufficient availability of plant and animal organisms as detritus is the last choice food (Veilleux & de Lafontaine 2007), but it may also reflect the short sampling period. The results obtained for the Gulf of Gdańsk and the Vistula Lagoon are similar to those obtained by Thiel (1938), Halat (1997), Rogers (2000) and Rudnick et al. (2000), who also indicated detritus as a regular component in the diet of *E. sinensis*.

When analyzing the results of research carried out in different water bodies, it should be considered that the stomach content often reflects the availability of food in the environment and not only the preferences of animals. Similar conclusions regarding the dietary differences depending on the habitat were obtained in research on other species of crabs, i.e. *R. harrisii*, *Ovalipes punctatus* as well as hermit crabs (*Pagurus criniticornis*, *Clibanarius antillensis*, *C. sclopetarius* and *C. vittatus* (Takahashi & Kawaguchi 2001; Turra & Denadai 2003; Hegele-Drywa & Normant 2009).

This study showed that the sex of an individual does not affect the type of food in the case of *E. sinensis*. It is interesting because, according to the literature, mainly males prey as they are usually more active and have a higher energy demand, so they eat more often and in large quantities (Barki et al. 2003). Due to their smaller claws, females have less crushing force than males, therefore they consume other organisms from the same taxonomic group (e.g. snails with a different shape of shells; Spooner 2007). Female crabs may also show a greater tendency to feed on items with soft tissues (Mantelatto & Christofoletti 2001). Our results show, however, that both sexes feed in a similar way, which is certainly affected by the fact that *E. sinensis* is a catadromous active species, taking long journeys throughout its life cycle and needs food that covers energy expenditure regardless of the sex. Likewise, no dietary differences between males and females of the Decapoda species were found by Goñi et al. (2001) for *Palinurus elephas*, Mantelatto & Christofoletti (2001) for *Callinectes ornatus* and Romero et al. (2004) for *Munida subrugosa*.

It is difficult to determine explicitly whether the size (age) of *E. sinensis* individuals affects the diversity of food consumed in the surveyed water bodies. These difficulties result from the varying age of the examined crabs. Crabs from the coastal waters of the Baltic Sea were adults with a carapace of over 33 mm wide, while crabs from the Tagus Estuary were young specimens, often with 21 mm carapace width. It can be assumed, however, that despite the lack of significant differences, there has probably been an ontogenetic diet shift – crabs choose different types of food depending on their age, i.e. small (young) individuals choose mainly food of plant origin, needed for frequent molting, while large (older) individuals prefer food of animal origin, which provides most of the necessary energy, and detritus needed in the process of breeding (Takahashi & Kawaguchi 2001; Turra & Denadai 2003; Aarnio et al. 2015). Such behavior was observed in other crab species, i.e. *R. harrisii* and the Asian shore crab *Hemigrapsus sanguineus*, whose herbivory decreased with increasing size (Griffen et al. 2012; Aarnio et al. 2015). Due to changes in dietary habits during the life cycle, *E. sinensis* may play two different roles (primary and secondary consumer) in the trophic chain (Aarnio et al. 2015), and its impact on the surrounding ecosystem will vary depending on its size.

The presented knowledge, combined with previous studies on dietary preferences and preferences regarding the size of prey (e.g. Wójcik et al. 2014; Wójcik-Fudalewska et al. 2016), will give us a better idea of *E. sinensis* feeding ecology.

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