MATING BEHAVIOUR OF THE CHINESE MITTEN CRAB
(ERIOCHEIR SINENSIS, H. MILNE EDWARDS, 1853)
IN THE ODRA ESTUARY: PRELIMINARY RESULTS

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Abstract

Chinese mitten crab is one of the largest invasive crustaceans in the waters of Europe and its presence poses a significant threat to biological diversity because of its number, omnivorousness and high fertility. An important limitation to proliferation of this catadromous species is the degree of water salinity. This paper reports on the possibility of mating of Chinese mitten crab migrating in autumn-winter through the Odra River estuary (Lake Dąbie) and coastal region of Pomeranian Bay, whose salinity is 0.2-1 PSU (fresh water) and 4-8 PSU (brackish water), respectively. The crabs caught in the period July-December 2010 were introduced in pairs into the tanks with oxygenated water of salinity the same as in the two respective water basins and observed. The experiment lasted from September 2010 to January 2011, mating pairs were observed from October to January with the greatest number of mating pairs in December (10.81% of the total number of pairs). From among 124 pairs in 41 pairs absolutely no contact was noted. In the remaining 83 pairs (66.93% of all individuals), some physical contact was observed including a fight in 31 pairs and other types of behaviour in 52 pairs. Among 83 pairs after physical contact, mating was observed only in 9 pairs kept in water of 8 PSU salinity (brackish water). The factor determining the mating behaviour of the crab was the water salinity. In the Odra River estuary the mating of the crab is possible only in the Pomeranian Bay and periodically in the northern part of the Szczecin Lagoon after autumn backwater events.

Key words: Chinese mitten crab, mating, behaviour, Odra estuary
**INTRODUCTION**

Chinese mitten crab (*Eriocheir sinensis*) is native to the region spreading from Fukien Province in China (26°N) to the Korean Peninsula (40°N) (Panning 1939, Hymanson et al. 1999, Dittel and Epifanio 2009). It is an invasive species in Europe. Most probably these animals were brought to Europe in ballast water on the ships from Far East in the beginning of the 20th century (Panning 1939, Grabda 1973). For the first time they have been noted in Europe in 1912 in the Wesser River, Germany, and two years later they were encountered in the Elba River (Panning 1939). In 1927 the first individuals were observed in Denmark, in 1930 in France, in 1931 in Holland, 1932 in Czech Republic and one year later they were reported from Belgium (Peters 1938, Panning 1939). In 1927 these crabs got to the Baltic Sea through the Danish Straits (Peters 1938), where they were spotted in coastal waters of Poland (Grabda 1973). This fast expansion of the species in Europe is a consequence of its high adaptability to new habitats and high fertility (Panning 1939, Dittel and Epifanio 2009). As suggested by Anger (1991), water salinity may affect on the fertility and survival of larvae stages of this crab. However, in the west part of the Baltic Sea and even in the coastal waters of Lithuania characterised by small salinity, some ovigerous females were noted (Ojaveer et al. 2007, Otto and Brandis 2011). These observations and the report by Herborg et al. (2006) on Chinese mitten crabs from the water of the Thames (UK) suggest that females can be fertilised in waters of smaller than hitherto assumed salinity. It has not been known if the Odra River estuary has a level of salinity satisfactory for the crabs to mate. The aim of this study was to establish the period of mating and the possibility of mating of Chinese mitten crab in different parts of the Odra River estuary having waters of different salinity.

**MATERIAL AND METHODS**

Chinese mitten crabs were collected from July 11th, 2010 to December 21st, 2010, using traps in the Lake Dąbie (water salinity of 0.2-1.0 PSU) and in the Pomeranian Bay (water salinity 4.0-8.0 PSU) (Landsberg, Uczciwek 2012) (Fig. 1). The first individuals were actually caught only on September 10th and the last ones on December 18th. The total number of individuals caught was 254, of which 102 came from the Lake Dąbie and 152 from the coastal zone of the Pomerania Bay. After each catch the crabs were separated according to sex and kept for two weeks in two aerated water tanks of 1000 dm$^3$ of capacity, in which water had the same salinity as that at the site of crab collection, that is in one tank – 0 PSU salinity (fresh water) which corresponded to the Lake Dąbie conditions and in the other tank – 8 PSU salinity (brackish water) which corresponded to the Pomeranian Bay conditions. After the two week period of acclimatisation, pairs of crabs were placed in separate aquariums of the size 50x50x40 cm, in which the water salinity was the same as at the sites of their collection, temperature was close to that in natural conditions, in natural light and under continuous aeration. While in the aquariums the pairs of crabs were carefully observed for two days and their behaviour was described (Herborg et al. 2006):
Contact: physical contact between any part of the two crabs.
Fighting: use of cheliped claws by at least one of the two individuals for aggressive behaviour.
Holding: male crab either rests his claws on the ventral or posterior part of the female carapace, or grasps the female by the posterior carapace or the 4th or 5th walking leg, without a visible struggle by the female. The male carapace can be either in horizontal or vertical position.
Mating position: male carapace is at an angle of 45° to vertical with at least the 2nd and 3rd pair of walking legs as well as the chelipeds grasping the raised female carapace, but the male abdomen and gonopods is not inserted into the female abdomen.
Mating: as for mating position, but with the male abdomen and gonopods inserted inside the female abdomen.

After the experimental observations the widths of crabs’ carapace were measured by an electronic calliper Helios to the accuracy of 0.01mm and the crabs were weighted on an electronic balance Radwag to the accuracy of 0.1 g.
RESULTS

From among 254 individuals the males predominated slightly (51.18%; 130 individuals). The males had wider carapaces and greater weight than females (Table 1). No statistically significant differences in these biological features were noted depending on the sites of animals collection.

Table 1

<table>
<thead>
<tr>
<th>Sex</th>
<th>Individuals number</th>
<th>Mass (g)</th>
<th>Carapax width (mm)</th>
<th>Carapax length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>♂</td>
<td>130</td>
<td>174.1±42.0</td>
<td>71.45±6.75</td>
<td>62.56±6.01</td>
</tr>
<tr>
<td>♀</td>
<td>124</td>
<td>127.1±39.7</td>
<td>67.12±6.45</td>
<td>59.64±5.76</td>
</tr>
<tr>
<td>Total</td>
<td>254</td>
<td>154.7±50.5</td>
<td>71.34±7.07</td>
<td>61.67±6.05</td>
</tr>
</tbody>
</table>

The 124 randomly selected pairs were introduced into separate aquaria for 2 days lasting close observations. In 41 pairs (33.06%) no physical contact between the animals was noted; usually they were hidden in the opposite corners of the tank. In 83 pairs (66.93% of all pairs) some form of physical contact was observed: in 31 pair by fight and in 52 pairs by some other forms of behaviour. A typical mating position was observed in 10 pairs, but the actual mating was noted in 9 pairs (7.83% of the population) (Fig. 2). It should be emphasised that mating was observed only among the pairs kept in the water of 8 PSU salinity. In spite of the same light conditions and temperature none of the pairs kept in aquarium with water of 0 PSU salinity actually mated. An interesting observation is that all the actually mating pairs

![Fig. 2. Types of behavior of crabs during the experiment](image-url)
were earlier observed to show aggressive behaviour (a kind of fight between different sex individuals).

In the period of the experiment (September 2010-January 2011) the mating pairs were observed from October to December (Fig. 3) with the greatest number of mating pairs in December (10.81% of the total number of pairs). In the other months the number of mating pairs was lower than 10%. In September, when 10 pairs only were observed no mating took place.

**DISCUSSION**

In the Odra River estuary the Chinese mitten crabs are most abundantly caught in the period of migration to breed, that is from October to December. In all the other months the total number of the crabs caught makes only 14.56% (Czerniejewski and Wawrzyniak 2006). That is why no individuals were caught in July and August. The periodicity of catch is typical of this catarodromous crustacean. A similar tendency has been observed in other European waters (Panning 1939, Robbins et al. 1999, Czerniejewski and Wawrzyniak 2006), in the USA (Rudnick et al. 2003) and in their native waters (Jin et al. 2002). Males are the first to start the breeding migration (Rudnick et al. 2003, Hoestlandt 1944), which explains a bit greater contribution of males caught in the Odra estuary. Moreover, according to the study by De Giosa and Czerniejewski (2011a, 2011b), the males have greater size of walking legs and claws, which not only facilitates mating but also permits faster movements and consequently they are easier to capture in traps. The migration to breed is undertaken by adult individuals, mature enough for mating, in the Odra River estuary they usually have the carapace width of 46.68-92.31mm and individual weight of 45.10-289.0 g
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During the migration lasting up to even 3 months (Herborg et al. 2003), they mate and lay eggs on the abdomen (pleopods). According to Panning (1939), this species needs for breeding a certain degree of water salinity, although as reported by Ojaveer et al. (2007), Rudnick et al. (2003), and our data, the mating and probably embryonic development may occur in water of much lower salinity than hitherto assumed. This supposition is supported by the fact that in China, individuals with gonads mature for mating were caught in fresh water (Hymanson et al. 1999).

In the crabs from the family Brachyura fertilisation usually takes place directly after the female has molted, while in the other species, including Chinese mitten crab, after carapace hardening (Herborg et al. 2006, Epifanio 2007). In the waters of China, the mating of this species is limited to the period from November to March (Zhang et al. 2001, Jin et al. 2002), in the waters of Great Britain – from October to February (Herborg et al. 2006), while in the Łaba River estuary – from October to January (Panning 1939). So, the mating of this species in the north part of the Odra River estuary takes place in the same period as in the Łaba River estuary. Probably, the crabs living in these two estuaries make stem from the same genetic population (Czerniejewski et al. 2012).

As follows from our results, Chinese mitten crabs can mate not only in water of high salinity (Panning 1939, Herborg et al. 2006), but also in water of salinity below 10 PSU, which means that they can mate in the water of the Pomeranian Bay and coastal regions of the Baltic Sea. Nevertheless, a greater number of mating pairs has been observed in water of greater salinity. In the conditions of our experiment, the contribution of mating pairs was only 7.83% of pairs, while in the waters of salinity of 15, 20 and 25 PSU, according to Herborg et al. (2006) these contributions were 10.4, 19.7 and 18.4%. In our experiment, no mating was observed in fresh water.

It should be noted that in the water of higher salinity not only the number of mating pairs was greater but also the number of pairs in which any form of physical contact took place (Herborg et al. 2006). It seems that water salinity is the factor determining the breeding of Chinese mitten crab. In the Odra River estuary the mating of this species seems possible only in the Pomeranian Bay and periodically in the northern part of the Szczecin Lagoon. In the water of the latter, in the events of autumn backwater the water salinity reaches 5-6 PSU (Poleszczuk and Piesik 2000).

REFERENCES


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Streszczenie

Jednym z najbardziej inwazyjnych nierodzimych gatunków skorupiaków w wodach Europy jest krab wełnistoszczypcy. W polskich wodach przybrzeżnych napotkać go można w estuarium Odry i Wisły oraz nielicznie w jeziorach przymorskich. Występowanie tego gatunku w wielu akwenach jest ograniczone brakiem możliwości rozrodu w wodach słodkich. Celem niniejszej pracy było określenie terminu oraz możliwości kopulacji krabów wełnistoszczypcych w różnych częściach estuarium Odry różniących się zasoleniem. Badania przeprowadzono w basenach z wodą charakteryzującą się zasoleniem zbliżonym do wód jeziora Dąbie oraz Zatoki Pomorskiej (odpowiednio 0% oraz 8%). Złowione w okresie lipiec-grudzień 2010 r. kraby wsiedlano parami do basenów i prowadzono obserwacje. Wśród 124 par u 83 par (66,93% krabów) stwierdzono kontakt fizyczny, w tym poprzez walkę (u 31 par), lub inne typy zachowania (52 pary). Wśród par, u których zaobserwowano kontakt fizyczny tylko u niewielkiej części krabów (10 par), zanotowano pozycję kopulacyjną, natomiast akt kopulacji zaobserwowano tylko u 9 par.

Podczas trwania eksperymentu (wrzesień-styczeń) pary kopulujące obserwowano od października do stycznia, z wyraźną dominacją ilościową par kopulujących w grudniu (10,81% łącznej liczby par). Do parzenia przystąpiły tylko pary przetrzymywane w akwariach o zasoleniu 8%. Stwierdzono, iż czynnikiem determinującym kopulację kraba wełnistoszczypcego jest zasolenie wód. W estuarium Odry kopulacja tego gatunku możliwa jest tylko w Zatoce Pomorskiej oraz okresowo po jesiennych wlewach słonawych wód Bałtyku w północnej części wód Zalewu Szczecińskiego.