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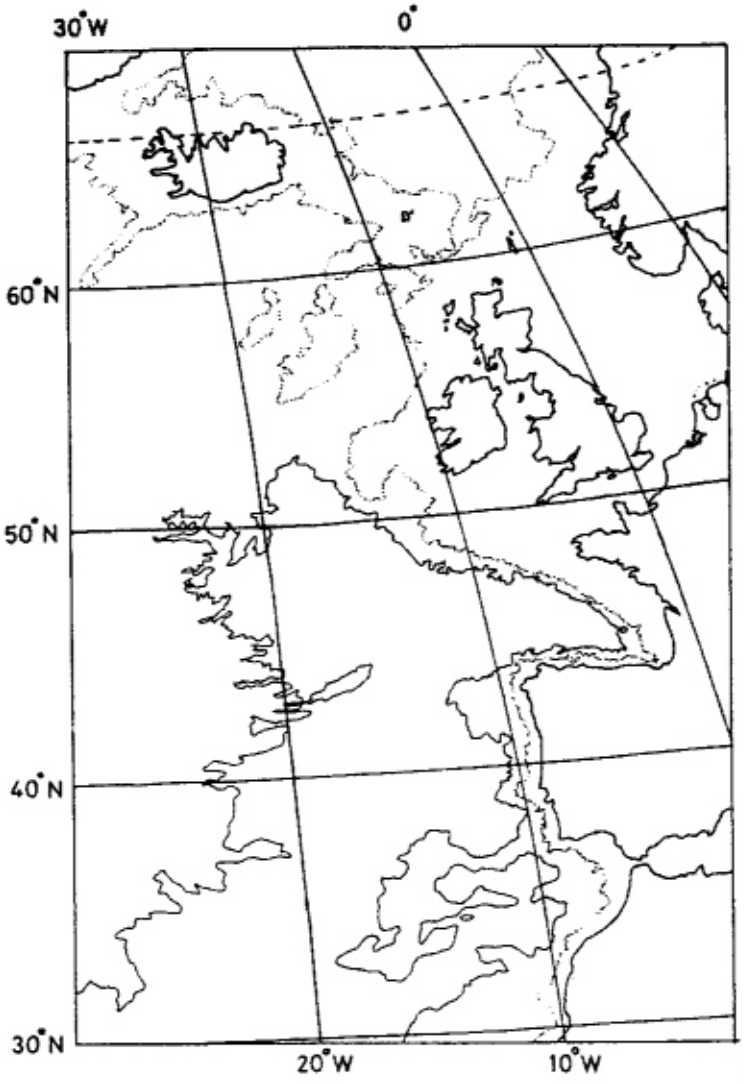

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Creature feature

Notes on the natural history of the edible crab, *Cancer pagurus* Linnaeus, 1758.

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Introduction:

Take a look into some of the cracks and crevices of the intertidal zone on the north coast of Cornwall and it won't be long before you find a juvenile edible crab staring back at you. These exposed shores are part of an extensive nursery area for the species.

Cancer pagurus Linnaeus, 1758 is commonly known as the edible or brown crab. '*Cancer*' is the Latin for crab and it seems possible that *pagurus* derives from '*pagur*' which was the Latin name for a type of fish, now unknown. So the literal translation of it's scientific name might be 'crab-fish', an interesting connection with the common convention to refer to many different crustaceans, molluscs and fin-fish as 'fish'.

Edible crabs are most common on rough grounds. Adults can often be found on shingle and shell gravels and have, exceptionally, been found down to depths of 520m. Juveniles live intertidally and in shallow inshore waters. One study in Pembrokeshire (Crothers, 1969) recorded peak abundances of small crabs between 5.5 and 11m depth.

It takes between 3 and 5 years for crabs to reach sexual maturity and they may live for up to 20 years. They continue to moult throughout their lives and may therefore grow to a very large size. The largest edible crab on record was a male or 'cock' crab with a carapace width of 267mm, landed from the English Channel fishery. The Channel is known to produce exceptionally large male specimens of the edible crab.

Food and Feeding:

Edible crabs will feed on a wide variety of prey. They are important predators of molluscs, taking gastropods such as dog whelks and winkles, mussels, scallops and burrowing bivalves, which they may dig down to depths of at least 20cm to find. But they will also attack other species of crab as well as echinoderms such as the sea urchin *Paracentrochus*. Edible crabs themselves fall prey to local predatory fish such the sea-bass, herring gulls, cormorants, octopus and of course, man.

The edible crab uses its powerful claws to crush molluscan prey. In the shore crab, *Carcinus maenas*, one cheliped has a crushing roll, the other a cutting, but in *Cancer pagurus* things are simplified and ambidextrous brute force prevails. Small gastropods are easily crushed by the powerful chelipeds, but the larger ones are more likely to suffer apertural breakage (Lawton and Hughes, 1985). A degree of finesse is required though, because the key to successfully breaking a shell is in the handling. Direct developers such as the dog whelk, *Nucella lapillus*, reflect this with shell shapes tending towards elongate forms with small apertures on shores with heavy crab predation. These forms increase the handling difficulty for the edible crab. *Littorina littorea* has an avoidance strategy to predation. It will climb higher up the shore to escape attacks. This response coupled with its dispersive pelagic larval phase means adaptations of shell shape are much less obvious, if seen at all, in this species.

Cancer pagurus is entirely non-selective in its choice of prey and will, for instance, indiscriminately attack all sizes of dog whelk. Picking up a large unprofitable gastropod, it may succeed only in damaging the shell without actually getting to the flesh. Indeed it has been observed to spend up to several hours on a single prey item even when others are available. They are clearly persistent creatures in this regard and coupled with their strength, the phrase 'brute force and ignorance' seems to strike fairly close to the descriptive-mark for *Cancer pagurus*!

One of the key strategies adopted by the crab when hunting agile epifaunal prey such as shore crabs, is the ambush (Lawton, 1989). The ambush can be expressed in three different ways. The first and most common is simply a grab response.

The second is a pounce and the third is to actively stalk the prey. These attacks on crabs such as *Porcellana platycheles, Pisidia longicornis, Pilumnus hirtellus, Galathea squamifera* and *Carcinus maenas* are not always successful. The edible crab may fumble the attack, mishandling the prey which makes its escape. Alternatively the prey may make a successful retaliation or if held fast it can shed the trapped limb just as *Cancer* itself will if one of its own legs is held fast by a predator. The ambush tactic used against the broad-clawed porcelain crab *Porcellana platycheles*, was more successful than head-on attacks.

In the subtidal environment the edible crab will forage over an area searching for and feeding on, prey like sedentary mussels and slow moving gastropods. Although unconfirmed in the wild it is thought that between these forays it will ambush opportunistically, any prey which happens to wander too close to its shelter.

Juveniles are likely to centre their own foraging behaviour around a shelter. They may seek to limit the time spent away from the relative safety of this shelter and in so doing, reduce the likelihood of falling victim to predation themselves. Prey items are therefore unlikely to be consumed in outside, exposed situations. This has been seen for juvenile lobsters, which leave their shelter only long enough to grab, non-selectively prey such as a mussel, before returning to the shelter to consume their food. If true for the edible crab, this would indicate that the availability of shelter is of no small importance to their survival.

Reproduction:

It is thought that a pheromonal identification and attraction mechanism may be in play as part of the mating process. Pairing occurs between crabs prior to mating when the female is about to moult and the male is between moults. Observations indicate that the male may help the female to shed the exo-skeleton she has outgrown. Copulation can then occur between the soft, newly moulted female and the male. It is thought that he then remains with the female until her soft covering has begun to harden.

The female stores the male's sperm within an enlargement of the genital duct called the spermatheca and the genital opening becomes sealed off by a structure referred to as the sperm plug. Perhaps it is the formation of this he is waiting for to ensure his undiluted reproductive success. The female may now choose to delay fertilization of her eggs for up to 15 months, so although she has mated she may not spawn until the following year. She also has the option of using her store of sperm to fertilize not just one but several batches of eggs.

Spawning usually takes place in late autumn or early winter. The female will search for areas of sand or gravel substrate, a soft area of seabed, where she can make a small hollow for her abdomen. Placing her abdomen in this depression she ensures the successful attachment of the fertilized eggs to her pleopods where they will develop, protected, for the next 7 to 9 months. With the eggs attached in this way she is said to be 'berried' or somewhat less poetically, ovigerous, and in this state she will overwinter without feeding.

At each spawning a female may produce between a quarter of a million and 3 million eggs depending on her size, with the larger females having the greater number of eggs. The main hatching period for North Sea and English Channel populations is from May to July and the newly hatched larvae enter the planktonic stage of their development which may last for up to 2 months. Mortality is high during this period and the rate at which the larvae develop as they are dispersed on the prevailing currents, is temperature dependent. By hatching during a period of increasing water temperature the time spent in the plankton is reduced. Although May-July is the main hatching window, edible crab larvae have been found in the plankton from March through to December. In the northeast Atlantic as a whole, numbers of crab larvae show seasonal peaks in April, June and August.

The size at which sexual maturity is reached depends on where the crab comes from and for females in particular this size may vary widely. The size of a crab is measured as the width across its carapace (the carapace width or cw). The smallest berried females reported by Bennett (1995) were as follows: English

Channel, 133mm; Irish Sea, 152mm; northern North Sea, 115mm; central North Sea, 129mm.

An earlier study by Edwards (1979) suggested a single figure for females of 127mm and for male crabs that those over 110mm were likely to be sexually mature. Edwards (1971) found that by their 4th year of development crabs had reached a cw of about 89mm and that it might not be until their 5th year that they exceed a cw of 110mm. In broader terms however crabs will reach sexual maturity in 3 to 5 years.

Juvenile crabs are found intertidally and in shallow inshore waters. It is worth highlighting here that there are critical gaps in our knowledge of juvenile edible crabs with only a limited understanding of behaviour, feeding, habitat needs, growth, mortality, predation or where settlement takes place. In addition there is little data on either stock or recruitment of juveniles.

Growth and moulting:

Tagging, or mark-and-recapture studies are used to gain an understanding of the frequency with which crabs moult and therefore of their growth. For juveniles the size increments at which moulting occurs are similar for both males and females.

In adults the case is very different and growth patterns can vary both within and between the sexes. One aspect that helps generate the gender divergence in growth is that females may partition energy towards egg production and this, of necessity, will limit their ability to grow. More broadly, growth patterns for *Cancer pagurus*, as with any animal, will vary considerably depending on key factors such as food supply and temperature. Imagine too the energy required to re-grow a lost limb and the consequent limitations placed on body-growth during that time.

Edible crabs which are about to moult, or have recently moulted will remain in a suitable shelter while the new shell hardens. Soft-shelled crabs are known to be more vulnerable and predators such as sea bass are adept at detecting this vulnerability. The crabs need calcium for the shells to harden and they may obtain this by consuming young specimens of the common mussel, *Mytilus edulis* (Karlsson and Christiansen, 1996). If the shelter is a little tight and the crab is somewhat jammed in against the rock then it may end up with some distortion to its carapace until the next moult.

In the English Channel the frequency with which the crabs moult decreases as they get bigger and females tend to moult less frequently than the males. In contrast, in the North Sea, while the general rule that moult frequency decreases with size holds true, the females tend to moult more frequently than the males. A comparison of the moult frequency of adult males between the two locations indicated that the males in the English Channel moulted with greater frequency than their counterparts in the North Sea.

To add further complexity to the story it has also been seen that within the English Channel population the annual growth rates for females in the south were higher than those in the north.

Lastly it is very important to qualify these findings by mentioning the confounding factors inherent in their derivation:

- the timing of the separate studies with relation to actual moulting periods;
- the fact that how catchable an individual is changes depending on where they are in the moult-cycle;
- the trap used may introduce a selection bias;
- the survival rates of moulted and non-moulted crabs is different;
- tags lost during moulting;
- tagged animals moving out of the study area;
- the stage of the reproductive cycle;
- annual variation ('good' and 'bad' years);
- genetic differences between stocks;
- environmentally derived controls or inducements.

All of which should indicate that in the application of growth models and size frequencies in any management strategy for the species, it is not only desirable but also necessary to adopt a precautionary, conservative approach.

One interesting aspect of growth and moulting is autotomy. Imagine an edible crab is under attack and one of its' limbs has been seized by a predator. How can it save itself? One option it may resort to is known as evasive autotomy. To escape its attacker the crab may sacrifice the limb. Autotomy is a Greek word derived from 'autos', self, and 'tomos', cutting. In practice this means that *Cancer pagurus*, in common with other crabs, is able to shed the seized or damaged limb along a predestined breakage plane. However the lost limb can only be replaced by moulting and the process may generate abnormalities.

Movement and range:

Male edible crabs are essentially nomadic and move in fairly random, localised ways with the larger ones ranging over greater areas. Conversely mature females may travel over large distances in a specific direction. These journeys are made against the prevailing residual current so that when eggs hatch the inevitable larval drift is compensated for to some degree (or so the theory goes). Does this make any intuitive/evolutionary sense? If the conditions for survival were optimal in the area that nurtured you, then perhaps it does.

In the North Sea off England the females, in addition to making seasonal inshore/offshore movements, will also journey great distances north up to southeast Scotland. In the English Channel the journey is to the west, except that for those females already in the west, the movement is to the south.

Another well-known migration is that which happens each autumn off the south coast of Devon. Large mature females move down into deeper waters where good spawning substrate can be found and where larvae can be dispersed by the prevailing easterly currents.

In temperatures of less than 5°C edible crabs will neither migrate nor feed. But when they are on the move individual crabs have been known to travel over 18km in a week.

Fisheries:

There are three 'true' crabs (i.e. brachyurans) fished for in UK waters, the thornback spider crab *Maja squinado*, the velvet swimmer crab *Necora puber* and the edible crab *Cancer pagurus*. Of these it is the edible crab that forms the basis of one of the most valuable income streams for our shell-fisherman (Ingle, 1996). The classic pie-crust look to the front margins of the carapace of *Cancer pagurus* lends it an entirely edible look even before we taste its flesh. Conversely the common or thornback spider crab presents a somewhat spikier problem for the marketing people both in looks and name.

Each of these species has a minimum landing size (mls). The first mls for the edible crab was set in 1877 at a carapace width (cw) of 108mm with the taking of berried crabs banned in the same year. In 1951 the mls was changed to 115mm. From January 1st 2000 the UK mls for edible crabs caught off Devon, Cornwall and the Isles of Scilly was set at a cw of 140mm for females and 160 mm for males. The European Union mls in the same waters is gender non-specific and set at 140mm.

Berried females and soft-shelled crabs may not be landed. Unfortunately there is no objective test for what constitutes a 'soft' crab and, in the English Channel at least, you are likely to find moulting crabs in most months.

The largest edible crabs are found offshore and the average size of trapped crabs increases with depth (true for both genders, juveniles and adults).

In one study, Bennett (1995) found that in the first half of the year in the western Channel most females caught were about 160mm. The mean cw of males caught was highest in spring and at this time the sex ratio of crabs caught was 1:1. By August the size of the females was up to 175mm and they made up 96% of the catch. In the eastern Channel male crabs consistently dominated the catch.

The catchability of females can vary widely. Berried females fast overwinter and are therefore only rarely caught. Post-ovigerous females in June/July are consequently more readily caught as they are hungry following their fast and need to build up their body reserves again. By autumn the females will have richly developed ovaries and those caught may give high yields of meat.

Pre-spawning aggregations are known to form in both the English Channel and North

Sea and during these times, the crabs are easily caught. This leaves them highly exposed to possible over-exploitation. It is thought that this autumn fishery could therefore prove damaging to stock recruitment and hence the long-term health of both the species and the fishery. On a somewhat less alarming note it may also be true that spawning grounds are spread more widely than the fishery.

Other threats to edible crabs in the offshore environment that should not be forgotten, particularly with regard to their possible impact on overwintering ovigerous females, include beam trawling, scallop dredging and aggregate extraction.

References:

The following references were consulted in the production of much of the above material, though, as ever, any mistakes, musings and misapprehensions are entirely my own. The 1995 paper by Bennett was an especially rich source of information and as such would be a good starting point for those interested in delving further into the scientific studies on the extraordinary edible crab.

Bennett, D.B. (1995). Factors in the life history of the edible crab (*Cancer pagurus* L.) that influence modelling and management. *ICES mar. Sci. Symp.* **199**, 89-98.

Crothers, J.H. (1969). The distribution of crabs in Dale Roads (Milford Haven: Pembrokeshire) during summer. *Field Studies* **3**, 109-124.

Edwards, E. (1979). *The edible crab and its fishery in British waters*. Fishing News Books Ltd., Farnham, Surrey. 142p.

Ingle, R.W. (1996). Shallow-water Crabs. *Synopses of the British Fauna* (New Series) No.25. Field Studies Council.

Karlsson, K. and Christiansen, M.E. (1996). Occurance and population composition of the edible crab (*Cancer pagurus*) on rocky shores of an islet on the south coast of Norway. *Sarsia* **81**, 307-314.

Lawton, P. (1989). Predatory interaction between the brachyuran crab *Cancer pagurus* and decapod crustacean prey. *Mar. Ecol. Prog. Ser.* **52**, 169-179.

Lawton, P. and Hughes, R.N. (1985). Foraging behaviour of the crab *Cancer pagurus* feeding on the gastropods *Nucella lapillus* and *Littorina littorea*: comparisons with optimal foraging theory. *Mar. Ecol. Prog. Ser.* **27**, 143-154.

Addendum to previous 'Creature Feature' article, 'Distribution of the Celtic sea-slug' (PMNHS Newsletter 13, October 2003)

Please note that there are several records of *Onchidella celtica* from the west coast of Scotland. However I have it on good authority (thanks are due to Shelagh Smith) that these finds probably represent adventitious and not over-wintering populations. To further confound expectation the two Scottish records were both collected from the sublittoral. As such it is my opinion that we should currently consider the west coast of Scotland finds to be ephemeral and not as yet, part of the established geographic distribution for *O.celtica*. Though of course the intriguing and interesting question remains, just how on earth did these animals get to the west coast of Scotland?

For those interested in a little more background on the Scottish question I refer you to the following two references:

Smith, S. (1987). *Onchidella celtica* (Forbes & Hanley, 1852) and other mollusca occasionally visiting western Scottish seas. *Porcupine Newsletter* **3** (10), (old series) 274-280.

Tween, T.C. (1987). *Onchidella* and the sublittoral. *Porcupine Newsletter* **4** (1), (old series)19-23.

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