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Marine Information Network
Information on the species and habitats around the coasts and sea of the British Isles

Green sea urchin (*Psammechinus miliaris*)

MarLIN – Marine Life Information Network
Biology and Sensitivity Key Information Review

Angus Jackson

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The Marine Life Information Network, Marine Biological Association of the United Kingdom.

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Psammechinus miliaris.
Photographer: Sue Daly

See online review for distribution map

Distribution data supplied by the Ocean Biogeographic Information System (OBIS). To interrogate UK data visit the NBN Atlas.

Researched by	Angus Jackson	**Refereed by**	Dr Maeve Kelly
Authority	(P.L.S. Müller, 1771)		
Other common names	-	**Synonyms**	-

Summary

Description

An almost round, slightly flattened urchin that grows up to 57 mm in diameter (although more typically to 35 mm diameter). It is greenish in colour with distinctive violet tips to the spines. The spines are robust, short and closely packed.

Recorded distribution in Britain and Ireland

All British and Irish coasts. Evenly distributed in the southern North Sea but scarce in northern North Sea.

Global distribution

From Trondheim Fjord in northern Norway, inner Danish waters from the Skaw into the western Baltic, Iceland, British Isles, south to the Atlantic coast of Morocco and the Azores. Not in Greenland, the Mediterranean or Atlantic coasts of America.

Habitat

Found intertidally on rocky shores under stones, boulders and seaweeds especially *Saccharina latissima*. Also found subtidally in seagrass beds or on mixed coarse bottoms such as muddy sand and gravel.

Depth range
0 -100 m

Identifying features

- Test sub-pentagonal and slightly depressed, with short, robust spines.
- Greenish in overall colour with violet tips to the spines
- Ambulacral plates have three pore pairs and one primary tubercle.
- Globiferous pedicellariae abundant, jaw blades grooved, with a row of sharp spines along each side.

Additional information

- Sometimes called the purple tipped sea urchin. Older publications may refer to sea urchins as "burrs" (Hancock, 1957). *Strongylocentrotus droebachiensis* is also known as the green sea urchin. It is possible for *Psammechinus miliaris* to be confused with *Strongylocentrotus droebachiensis* or pale specimens of *Paracentrotus lividus*.
- A regular sea urchin with a somewhat flattened test. The colour varies with habitat (Bull, 1939; Lindahl & Runnström, 1929; Comely, 1979). Shallow water or littoral individuals are a deep purplish-brown and show no difference between the colour of the test and spines. Those from deeper water tend to be paler in colour, with a light green test and vivid purple spine tips.
- The tube-feet are arranged in arcs of 3, visible as 3 pairs of pores corresponding with each ambulacral plate on the denuded test.
- A typical species of bouldered sheltered shores, also found sublittorally in shallow water in sheltered or slightly brackish sites such as sea lochs. Common in the circalittoral on exposed shores in Shetland.

MarLIN would like to thank Dr Maeve Kelly for her comments and significant additions to the review.

Listed by

Further information sources

Search on:

NBN WoRMS

Biology review

Taxonomy

Phylum	Echinodermata Starfish, brittlestars, sea urchins & sea cucumbers
Order	Camarodonta
Family	Parechinidae
Genus	Psammechinus
Authority	(P.L.S. Müller, 1771)
Recent Synonyms	-

Biology

Typical abundance	High density
Male size range	typically <40mm
Male size at maturity	8-10mm
Female size range	8-10mm
Female size at maturity	
Growth form	Globose
Growth rate	See additional information
Body flexibility	None (less than 10 degrees)
Mobility	
Characteristic feeding method	Active suspension feeder
Diet/food source	
Typically feeds on	Macroalgae, hydroids, bryozoans, boring sponges, barnacles, mussels, cockles and worms (see Lawrence, 1975).
Sociability	
Environmental position	Epifaunal
Dependency	Independent.
Supports	None See additional information.
Is the species harmful?	No See additional information

Biology information

Abundance

In Scotland *Psammechinus miliaris* typically occurs in dense, localized populations in sheltered areas of sea lochs on the west coast (Davies, 1989; Holt, 1991). Densities have been recorded of 18 individuals per 100 g dry weight of sea weed (Bedford & Moore, 1985); several /m^2 in beam trawls in the Wadden Sea (Cranmer, 1985); 34 individuals per m^2 in a subtidal *Saccharina latissima* (studied as *Laminaria saccharina*) bed, 182.4 /m^2 in a shallow bed of *Zostera* and 28.4 /m^2 on adjacent mud surfaces (Comely, 1979) and 352 /m^2 for littoral populations (Kelly, 2000) where individuals in one 0.25 m^2 quadrat ranged from 3.7 to 24.2 mm horizontal test diameter. Densities of several individuals /m^2 have been recorded in the German Waddensea (Ursin, 1960). Larsson (1968) found up to 10 individuals /m^2 in Saltkälle Fjord, Sweden.

Size

Maximum size varies with location. In some places the maximum diameter reached is small (< 20 mm (Jensen, 1969); around 35 mm (Bedford & Moore, 1985; Gage, 1991; Bull, 1939) although others have recorded diameters up to 57.5 mm (Allain, 1978) or up to 50 mm (Massin, 1999b; Aquascope, 2000a). The minimum diameter at maturity recorded (Brattström, 1941 cited in Jensen, 1969) is 6-7 mm but more usually 8-10 mm.

Growth rates

Estimates of growth rate vary. Gage, (1991) tried to relate growth bands found in the calcified plates of the test to seasonal differences in skeletal growth rate. This approach can be used reasonably accurately for estimating age of young urchins. However, when growth slows down, the reduced distance between bands make it difficult to distinguish individual markings. Bull, (1939) recorded growth up to 20 mm test diameter in the first year which then slowed considerably. In the second year mean diameters increased from 20 to 26.2 mm and by the sixth year saw growth of only a further 12 mm or so. Jensen, (1969) found that newly settled urchins (in August) grew 2 mm in the first 2 months and had reached 5.8 mm by the following July. Growth was recorded as maximal in spring and early summer by Gage (1991) and Bedford & Moore (1985) but work by Jensen, (1969) showed no growth between May and October. Growth rates of cultivated *Psammechinus miliaris* are given by Cook *et al.* (1998).

Locomotion

Locomotion is mediated by the movable spines attached to the test. The echinoid test is very brittle and easily damaged by impact. The spines which are articulated at the base and controlled by muscles may provide some cushioning to impact but overall the flexibility is negligible.

Feeding

Psammechinus miliaris has been recorded as feeding on a wide variety of species (see Lawrence, 1975). Loose lying brown macro algae, particularly *Saccharina latissima* (studied as *Laminaria saccharina*), is probably the main nutrient source although softer green algae such as *Ulva lactuca* may be important when small (Cook *et al.*, 1998). The green sea urchin also feeds on epifauna such as hydroids, barnacles, small bivalves, boring sponges (e.g. *Cliona*), worms (e.g. *Polydora*) (Hancock, 1957; Lawrence, 1975).

Parasites

Psammechinus miliaris (as well as other echinoderms) frequently harbours a polychaete, *Flabelligera affinis* amongst the spines.

Use

The gonads of *Psammechinus miliaris*, but more commonly *Paracentrotus lividus*, are eaten as a delicacy in Mediterranean countries. As wild populations of *Psammechinus miliaris* typically have small gonads, its potential for aquaculture is being investigated (Kelly *et al.*, 1998).

Habitat preferences

Physiographic preferences	Open coast, Offshore seabed, Strait / sound, Sea loch / Sea lough, Ria / Voe
Biological zone preferences	Lower circalittoral, Lower eulittoral, Lower infralittoral, Mid eulittoral, Sublittoral fringe, Upper circalittoral, Upper infralittoral

Substratum / habitat preferences	Macroalgae, Artificial (man-made), Bedrock, Cobbles, Gravel / shingle, Large to very large boulders, Mixed, Muddy gravel, Muddy sand, Rockpools, Small boulders, Under boulders
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.)
Wave exposure preferences	Extremely sheltered, Moderately exposed, Sheltered, Very sheltered
Salinity preferences	Full (30-40 psu), Variable (18-40 psu)
Depth range	0 -100 m
Other preferences	No text entered
Migration Pattern	Non-migratory / resident

Habitat Information

The species is found in the intertidal and subtidal, occasionally as deep as 100 m (Mortensen, 1927) but more commonly between 16 -70 m (Cranmer, 1985) or 0 -10 m in Scottish sea lochs (Kelly, 2000).

On the west coast of Scotland *Psammechinus miliaris* typically occurs in dense, localized populations in sheltered areas of sea lochs (Davies, 1989; Holt, 1991). Its distribution frequently coincides with that of the brown seaweed *Saccharina latissima*, with *Psammechinus miliaris* occurring on the fronds as well as on rock surfaces below the fronds. Some populations are exposed to air at low spring tides, and are found attached to the underside of rocks, boulders and seaweed, or shallowly buried under gravel on the foreshore (Kelly, 2000). Individuals from the intertidal and subtidal habitats on the west coast of Sweden were termed 'Z' and 'S' forms by Lindahl & Runnström (1929). The 'Z' form lived in the 'seaweed region' and were larger and darker than the 'S' forms found at greater depths.

Comely (1979) described a population of *Psammechinus miliaris* from a *Zostera marina* bed in a stable salinity, shallow inlet in Loch Sween, Scotland. Theses individuals were found on the bottom mud and attached to the rhizomes of *Zostera* at depths of 1 -2 m. Very young individuals have been found in the holdfasts of *Laminaria* from the Clyde Sea, Scotland (Moore, 1971).

Psammechinus miliaris is often found on man-made surfaces such as bridge supports and wrecks.

Life history

Adult characteristics

Reproductive type	Gonochoristic (dioecious)
Reproductive frequency	Annual protracted
Fecundity (number of eggs)	>1,000,000
Generation time	1 year
Age at maturity	1 year
Season	May - October
Life span	5-10 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Planktotrophic
Duration of larval stage	1-2 months
Larval dispersal potential	Greater than 10 km
Larval settlement period	Insufficient information

Life history information

Longevity
Gage (1991) tried to use skeletal growth bands to estimate the age of urchins but this approach proved to be difficult to use in older specimens due to the proximity of growth lines during slow growth in older individuals. Bull, (1939) estimated longevity to be up to 6 years, Jensen, (1969) up to 8 years and Alain, (1978) up to 10 or 12 years.
Maturity
Elmhirst (1922; cited in Gage, 1991) noted that maturity was reached in the first year after settlement. In contrast, Jensen (1969) found 75 % of one year old urchins to have immature gonads in their first summer. However, Kelly (2001) noted that one year old *Psammechinus miliaris* produced viable gametes and were able to breed in the laboratory.
Spawning (see additional images)
Individuals have been recorded as having ripe gonads from as early as February to as late as November (Orton, 1923; Sukarno *et al*., 1979; Mortensen, 1927). Actual breeding occurs in spring and early summer (Mortensen, 1927; Sukarno *et al*., 1979; Kelly, 2000). *Psammechinus miliaris* is a broadcast spawner (Massin, 1999(b)). The spawning period has been reported to be June to August in the Clyde Sea area (Elmhirst, 1922); June to October near Bergen, Norway (Runnström, 1925; cited in Lindahl & Runnström, 1929); June to October and May to October in West Norway and Denmark (Jensen, 1969); and July and August on the west coast of Scotland (Comely, 1979). *Psammechinus miliaris* from two typical habitats (littoral and sublittoral) on the west coast of Scotland had a defined annual cycle of gametogenesis with a single spawning period (Kelly, 2000) and gonad indices that peaked in June and July.
Fecundity
Estimates of fecundity suggest that females produce between 80,000 and 2,500,000 eggs in a single spawning event (Dr Maeve Kelly, unpublished observations). Breeding probably occurs over a couple of months (Kelly, 2000) but whether individuals breed for this entire period or whether this duration is for a whole population is uncertain. Orton (1923) suggests there is no evidence for collective spawning.

Sensitivity review

This MarLIN sensitivity assessment has been superseded by the MarESA approach to sensitivity assessment. MarLIN assessments used an approach that has now been modified to reflect the most recent conservation imperatives and terminology and are due to be updated by 2016/17.

Physical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Substratum Loss	High	High	Moderate	High

Psammechinus miliaris lives and feeds on a variety of substrata. Loss of substratum will cause mortality. Adult urchins are mobile but probably not active over large distances so recolonization is unlikely to occur through adult immigration. *Psammechinus miliaris* is quite long lived (up to 12 years) (Allain, 1978), and can breed within one year of settlement (Kelly, 2001). Breeding occurs in spring and summer each year (Mortensen, 1927; Sukarno *et al*., 1979; Kelly, 2000), fecundity is likely to be high (MacBride, 1903) and the larvae are long lived (20-40 days) (Jensen, 1969; Massin, 1999b; Kelly *et al*., 2000). Dispersal potential is therefore large and recoverability is likely to be high.

Smothering	High	High	Moderate	Low

Psammechinus miliaris is an epibenthic species that, although mobile, is not highly active and moves using mobile spines. This urchin species is quite small (typically up to 40 mm) and is likely to be completely covered by 5 cm of sediment. It is probable that the urchin would be unable to 'dig out' of the sediment. Adult urchins are mobile but probably not active over large distances so recolonization is unlikely to occur through adult immigration. *Psammechinus miliaris* is quite long lived (up to 12 years) (Allain, 1978), and can breed within one year of settlement (Kelly, 2001). Breeding occurs in spring and summer each year (Mortensen, 1927; Sukarno *et al*., 1979; Kelly, 2000), fecundity is likely to be high (MacBride, 1903) and the larvae are long lived (20-40 days) (Jensen, 1969; Massin, 1999b; Kelly *et al*., 2000). Dispersal potential is therefore large and recoverability is likely to be high.

Increase in suspended sediment	Low	Very high	Very Low	Low

It is unlikely that changes in siltation rate will have a great effect on this species. *Psammechinus miliaris* grazes on macroalgae and some encrusting faunal species so increases in siltation are unlikely to affect feeding. Increases in siltation rate will increase the amount of sediment settling out onto the urchin. There may be an increased energetic cost to clearing these particles. Energetic expenditure may result in loss of condition or compromise gonadal and somatic growth. On removal of the factor, recovery should take only a short time.

Decrease in suspended sediment

Dessication	High	High	Moderate	High

Psammechinus miliaris is found subtidally and intertidally. In intertidal regions the urchin is typically found in crevices and under boulders or weed where the risk of desiccation is minimized. However, relative humidity and temperature strongly influence survivorship of *Psammechinus miliaris*. Cook (1999) found that *Psammechinus miliaris* from littoral populations were more tolerant of an increased temperature and decreased relative humidity during aerial exposure than those from subtidal populations. *Psammechinus miliaris* from the littoral zone show slightly more tolerance to exposure at 60% relative humidity and 10 °C than those from sublittoral populations. At high relative humidity (95%), 95% of *Psammechinus miliaris* can withstand 72 hours exposure to air if kept chilled at 5 °C. But at 20 °C and 95% humidity, no *Psammechinus miliaris* survived 72 hours exposure (Cook, 1999; Dr Maeve Kelly, pers comm.). Therefore, it is likely that individuals exposed to an increase in desiccation at the benchmark level will die. Therefore, an intolerance of high has been recorded. Recruitment to the remaining population will probably occur by larval settlement from the plankton. Recoverability is likely to be high (see additional information).

Increase in emergence regime	Low	Low	Moderate	Low

Psammechinus miliaris is unlikely to be intolerant of changes in emergence regime. Although not highly active, the species is sufficiently mobile to be able to relocate to more suitable conditions.

Decrease in emergence regime

Increase in water flow rate	Low	Very high	Very Low	Low

Psammechinus miliaris holds itself onto the substratum using suction pads at the end of its tube feet (Massin, 1999b) Large increases in water flow rate may make it more difficult to remain on the substratum. The urchin *Echinus esculentus* has been observed to be 'rolled' by water currents (Comely & Ansell, 1988). Displacement from the substratum is unlikely to cause damage or death. Relocation back to a suitable or preferred location will incur an energetic cost. Energetic expenditure may result in loss of condition or compromise gonadal and somatic growth. On removal of the factor, recovery should take only a short time.

Decrease in water flow rate

Increase in temperature	Low	Low	Moderate	Moderate

The species is recorded as occurring in water temperatures of between 4-17 °C. Ursin (1960) reported that *Psammechinus miliaris* had a high tolerance of low temperatures and that it is found in Limfjord, Denmark, where winter temperatures are just above zero. It reproduces in waters around the Faeroes where the summer temperatures seldom exceed 11 °C (Ursin, 1960). The geographical distribution of *Psammechinus miliaris* extends to the north and south of the British Isles into colder and warmer waters respectively. Consequently, long term chronic changes in temperature are unlikely to have a great effect on populations of *Psammechinus miliaris* in the British Isles. Therefore, an intolerance of low has been recorded. Recoverability is likely to be rapid. However, exposure to high temperatures in the intertidal will increase the risk of desiccation (see above).

Decrease in temperature

Increase in turbidity	Low	Very high	Very Low	Moderate

Moore (1977) suggested that *Echinus esculentus* was unaffected by turbid conditions. *Psammechinus miliaris* can inhabit similar kelp habitats to *Echinus esculentus* and may be similarly tolerant. However, increased turbidity and resultant reduced light penetration is likely to affect macroalgal populations e.g. kelps, which are a preferred food species for *Echinus esculentus*. However, it can feed on alternative prey, detritus or dissolved organic material (Lawrence, 1975, Comely & Ansell, 1988). Conversely, decreases in turbidity may benefit algal growth. Reduced food availability may cause loss of condition or compromise gonadal and somatic growth. When food availability is returned to 'normal' recovery should take only a short time.

Decrease in turbidity

Increase in wave exposure Intermediate High Low Moderate

Psammechinus miliaris occurs both in subtidally and inter-tidally from coasts all round the British Isles but is typically found in more sheltered environments. It has a lower tolerance of wave exposure than *Echinus esculentus* and *Paracentrotus lividus*, the latter being found on the exposed. It is likely that high levels of wave exposure limits the distribution of *Psammechinus miliaris* in the intertidal and subtidal (Dr Maeve Kelly, pers comm.). As *Psammechinus miliaris* feeds on a wide selection of algae and encrusting organisms (Lawrence, 1975) its distribution is thought to be limited more by physical parameters than food availability (Faller-Fritsch & Emson, 1972; cited in Lawrence, 1975). Therefore, an increase in wave exposure at the benchmark level is likely to remove at least a proportion of the population and an intolerance of intermediate has been recorded. Recruitment to the remaining population will occur by larval settlement from the plankton. Recoverability is likely to be high.

Decrease in wave exposure

Noise Tolerant Not relevant Not sensitive Very low

No evidence of sound or vibration reception in echinoids was found.

Visual Presence Low Very high Very Low Moderate

Psammechinus miliaris is likely to have slight intolerance to visual disturbance. Like many other echinoids it avoids bright light (Massin, 1999(b)). This species is recorded as having a behavioural response to changes in shading. Sudden shading results in withdrawal of the tube feet (Millott & Yoshida, 1956) The degree of response depends on light intensity and the degree of intensity change. Other echinoid species are also recorded as having a shading response, with spines being brought round to point in the direction of the stimulus as a protective mechanism. The reaction is likely to be short lived and insignificant. This response may interfere with feeding and if this occurs repeatedly then loss of condition or reduced somatic and gonadal may result. On removal of the stimulus, recovery of condition should not take long.

Abrasion & physical disturbance Intermediate High Low High

The test of *Psammechinus miliaris* is brittle and easily damaged by impact or abrasion. Spines and podia may be damaged or broken off. The spines may provide some degree of cushioning for the test. Beam trawling was reported to remove ca 20 to 50% of this species (Kaiser & Spencer, 1994a), and the impact of scallop dredging is likely to be similar. Damage to the test will generally be lethal, if not outright because internal organs become exposed to predators and possible infection. However, the frequency of occurrence of *Psammechinus miliaris* was reported to increase markedly over an 80 year period in trawled areas in the southern North Sea (Rumohr & Kujawski, 2000). Overall, the evidence from Kaiser & Spencer (1994a) suggests that a proportion of the population is likely to be removed and intolerance has been assessed as intermediate. Some repair and regrowth of minor damage to the test and spines may be possible. Recoverability is likely to be high (see additional information below).

Displacement Tolerant Not relevant Not sensitive High

Psammechinus miliaris is mobile and may be also regularly displaced by wave action or water currents. Some damage may be caused by loss of tube feet during a displacement event but this is repairable. As with *Echinus esculentus* (Lewis & Nichols 1979b), displaced specimens are able to relocate. This will probably have negligible effect on the species.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	High	High	Moderate	High

Considerable observations and work, mainly on *Echinus esculentus* but also on *Psammechinus miliaris* (Smith, 1968; Gomez & Miguez-Rodriguez, 1999; Dinnel *et al.*, 1988) indicate high intolerance to synthetic contaminants. Newton & McKenzie (1995) state that echinoderms tend to be very intolerant of various types of marine pollution, but there is little more detailed information than this. Following the *Torrey Canyon* incident, large numbers of dead *Psammechinus miliaris* in the vicinity of Sennen, presumably due to the heavy spraying of dispersants in that area and exposure to the oil spill (Smith, 1968). Therefore, an intolerance of high has been reported. Recoverability is likely to be high (see additional information below).

Heavy metal contamination	Intermediate	High	Low	Low

Little is known about the effects of heavy metals on adult echinoderms although Newton & McKenzie (1995) state that echinoderms tend to be very sensitive to various types of marine pollution. In an area around Naples, with high concentrations of lead, zinc and copper, the urchins *Paracentrotus lividus* and *Arbacia lixula* were smaller than those at unpolluted sites further along the coast (Sheppard & Bellamy, 1974) probably due to either restricted growth or individuals dying before reaching adult size. Abundance was also lower in polluted sites and so intolerance of adults has been assessed as intermediate. Echinoderm larvae are know to be especially intolerant of heavy metals (Bryan, 1974). Recoverability is likely to be high (see additional information below).

Hydrocarbon contamination	High	High	Moderate	High

Echinoderms seem especially sensitive to the toxic effects of oil, likely because of the large amount of exposed epidermis (Suchanek, 1993). Following the *Torrey Canyon* incident, large numbers of dead *Psammechinus miliaris* in the vicinity of Sennen, presumably due to exposure to the oil spill and the heavy spraying of hydrocarbon based dispersants in that area (Smith, 1968). Other significant effects have been observed in other species of urchins. For example, mass mortality of the echinoderm *Echinocardium cordatum* was observed shortly after the *Amoco Cadiz* oil spill (Cabioch *et al.*, 1978) and reduced abundance of the species was detectable up to > 1000m away one year after the discharge of oil-contaminated drill cuttings in the North Sea (Daan & Mulder, 1996). In the Mediterranean around Naples, urchins were absent from areas which has visible signs of massive pollution of both sewage and oil. *Echinus esculentus* populations in the vicinity of an oil terminal in A Coruna Bay, Spain, showed developmental abnormalities in the skeleton. The tissues contained high levels of aliphatic hydrocarbons, naphthalenes, pesticides and heavy metals (Zn, Hg, Cd, Pb, and Cu) (Gomez & Miguez-Rodriguez 1999). But the observed effects may have been due to a single contaminant or synergistic effects of all present. However, it appears likely that echinoids such as *Psammechinus miliaris* are highly intolerant of hydrocarbon contamination. Recoverability is likely to be high (see additional information below).

Radionuclide contamination				Not relevant

Insufficient information

Changes in nutrient levels	Low	Very high	Very Low	Moderate

It is unlikely that changes in nutrient concentration will directly affect *Psammechinus miliaris* populations. The addition of nutrients may encourage the growth of ephemeral and epiphytic algae and therefore increase the food available to populations of grazing sea-urchins such as *Psammechinus miliaris*. Conversely, decreases in nutrient availability may limit growth of algae used as a nutrient source. Lawrence (1975) reported that sea urchins had persisted over 13 years on barren grounds near sewage outfalls, presumably feeding on dissolved organic material, detritus, plankton and microalgae, although individuals died at an early age. The ability to absorb dissolved organic material has been suggested by Comely & Ansell (1988). Reduced food availability may cause loss of condition or compromise gonadal and somatic growth. Increased food availability may cause the population to expand in number or extent. When food availability is returned to 'normal', recovery should take only a short time.

Increase in salinity	Intermediate	High	Low	Moderate

Echinoderms are generally unable to tolerate low salinity (stenohaline) conditions and possess no osmoregulatory organ (Boolootian, 1966). There is some evidence for intracellular regulation of osmotic pressure due to increased amino acid concentrations. Populations of *Psammechinus miliaris* occur both in the sub-tidal and inter-tidal. The latter must encounter reduced salinity due to fresh water runoff or heavy rain and hence be able to tolerate variable salinity. Lindahl & Runnström (1929) showed through acclimatisation experiments that *Psammechinus miliaris* from the littoral (Z form) and sublittoral (S form) had different salinity optima. Gezelius (1962) showed that eggs from the Z and S forms of *Psammechinus miliaris* differed in the range of salinities they would tolerate and over which fertilization would successfully occur, 20-32 psu and 26-38 psu at 17-19 °C respectively. At low salinity urchins gain weight and the epidermis loses its pigment as patches are destroyed; prolonged exposure is fatal. Therefore, a short term acute decrease in salinity may cause mortality, especially in sublittoral populations, and an intolerance of intermediate has been recorded. Recoverability is likely to be high (see additional information below).

Decrease in salinity

Changes in oxygenation	Intermediate	High	Low	Moderate

Under hypoxic conditions echinoderms become less mobile and stop feeding. Death of a bloom of the phytoplankton *Gyrodinium aureolum* in Mounts Bay , Penzance in 1978 produced a layer of brown slime on the sea bottom. This resulted in the death of fish and invertebrates, including *Echinus esculentus*, presumably due to anoxia caused by the decay of the dead dinoflagellates (Griffiths *et al*., 1979). Spicer (1995) investigated the effects of environmental hypoxia on the oxygen and acid-base status of *Psammechinus miliaris*. Oxygen uptake is not regulated by this species during progressive hypoxia. The habitat of this species includes rock pools on the shore that can experience quite severe hypoxia or even anoxia. *Psammechinus miliaris* must be able to tolerate low oxygen conditions provided the event is brief. In prolonged events, subtidal *Psammechinus miliaris* would presumably react in a similar fashion to the *Echinus esculentus* above. Recoverability is likely to be high (see additional information below).

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of microbial pathogens/parasites	Intermediate	High	Low	Moderate

Psammechinus miliaris is susceptible to 'Bald-sea-urchin disease', which causes lesions, loss of spines, tube feet, pedicellariae, destruction of the upper layer of skeletal tissue and death (Maes *et al*., 1986). It is thought to be caused by the bacteria *Vibrio anguillarum* and *Aeromonas salmonicida*. This disease has been recorded from *Psammechinus miliaris* from the French Atlantic coast. Although associated with mass mortalites of *Strongylocentrotus franciscanus* in California and *Paracentrotus lividus* in the French Mediterranean there is no evidence of mass mortalities of *Psammechinus miliaris* associated with this disease around Britain and Ireland. an intolerance of intermediate has therefore been recorded. Recoverability is likely to be high (see additional information below).

Introduction of non-native species	Tolerant	Not relevant	Not sensitive	Low

No alien or non-native species is known to prey on, compete with or adversely (or otherwise) affect *Psammechinus miliaris*.

Extraction of this species	Intermediate	High	Low	Low

Psammechinus miliaris is now targeted as a potential aquaculture species since when fed a nutritious diet in culture, the gonad biomass rapidly proliferates (Kelly *et al*., 1998). A study of a littoral and sublittoral population, Kelly (2000) concluded that there was no evidence of an opportunity for a commercial fishery because of the low gonad content of wild populations. However, some extraction of *Psammechinus miliaris* may conceivably develop for roe-enhancement through feeding artificial or nutrient enriched diets (Dr Maeve Kelly pers comm.). Therefore, an intolerance of intermediate has been recorded. The aquaculture potential of this smaller species is being investigated (Kelly *et al*., 1998). Recoverability is likely to be high (see additional information below).

Extraction of other species	Intermediate	High	Low	Moderate

Both sub-tidal and inter-tidal populations of *Psammechinus miliaris* are often intimately associated with macro algae, particularly with kelp beds, both attached and loose lying. Physical effects associated with removal of other species (such as kelp) are addressed in the relevant factors above. Therefore, extraction of seaweed species is likely to result in the loss of some individuals of *Psammechinus miliaris*. This species may also suffer as a result of trawling or dredging for other benthic species. Species with fragile tests such as urchins have been reported to be particuarly sensitive to damage from mobile fishing gear (see Jennings & Kaiser, 1998; Bergman & van Santbrink, 2000). Kaiser & Spencer (1994a) reported a ca 20 - 50% mortality in *Psammechinus miliaris* as a result of a single pass of an experimental 4 m beam trawl. However, the frequency of occurrence of *Psammechinus miliaris* was reported to increase markedly over an 80 year period in trawled areas in the southern North Sea (Rumohr & Kujawski, 2000). Overall, the evidence from Kaiser & Spencer (1994a) suggests that a proportion of the population is likely to be removed and intolerance has been assessed as intermediate. Recoverability is likely to be high (see additional information below).

Additional information

Recoverability

Adult urchins are mobile but probably not active over large distances so recolonization is unlikely to occur through adult immigration. *Psammechinus miliaris* is quite long lived (up to 12 years) (Allain, 1978), and can breed within one year of settlement (Kelly, 2001). Breeding occurs in spring and summer each year (Mortensen, 1927; Sukarno *et al*., 1979; Kelly, 2000), fecundity is likely to be high (MacBride, 1903) and the larvae are long lived (20-40 days) (Jensen, 1969; Massin, 1999b; Kelly *et al*., 2000). Dispersal potential is therefore large and recoverability is likely to be high.

Importance review

Policy/legislation

- no data -

Status

National (GB) importance	-	**Global red list (IUCN) category**	-

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

- *Psammechinus miliaris* occurs in a diverse range of habitats, frequently at high densities, particularly in shallow or littoral location. Its is omnivorous (see Hancock, 1957; Lawrence, 1975). It is likely that the grazing activity of *Psammechinus miliaris* has a profound impact on the biodiversity and distribution of subtidal and intertidal encrusting invertebrates as well as flora. However, field studies that demonstrate the extent to which *Psammechinus miliaris* regulates the structure of these communities are lacking (Dr Maeve Kelly, pers comm.).
- Echinoderms such as *Psammechinus miliaris* and *Echinus esculentus* often provide shelter for a commensal species of bristle worm, *Flabelligera affinis* (Mortensen, 1927).
- *Psammechinus miliaris* is beginning to be cultivated for a substitute source of sea urchin gonads (formerly from *Paracentrotus lividus*), considered a delicacy in continental Europe. To accommodate this demand, investigations are being made into the feasibility of culturing *Psammechinus miliaris*, particularly into polyculture of this species in salmon farm cages (Kelly *et al*., 1998). This species appears to grow better when fed on artificial animal derived protein (salmon feed pellets) than when on a normal diet (Cook *et al*., 1998; Kelly *et al*., 1998). However, based on a study of a littoral and sublittoral population, Kelly (2000) concluded that there was no evidence of an opportunity for a commercial fishery because of the low gonad content of wild populations. However, some extraction of *Psammechinus miliaris* may conceivably develop for roe-enhancement through feeding artificial or nutrient enriched diets (Dr Maeve Kelly pers comm.).
- *Psammechinus miliaris* is predated upon by starfish, crabs and some fish, e.g.. the wolf fish *Anarhichas lupus*. Populations at low tide can be subject to predation by birds such as gulls and oyster catchers.

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