Basket shell (*Corbula gibba*)

MarLIN – Marine Life Information Network
Marine Evidence–based Sensitivity Assessment (MarESA) Review

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***Corbula gibba*.**
Photographer: Dr Sebastian Holmes
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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	Marisa Sabatini & Susie Ballerstedt	**Refereed by**	This information is not refereed.
Authority	(Olivi, 1792)		
Other common names	-	**Synonyms**	-

Summary

Description

Corbula gibba has a plump, broadly oval to triangular shell up to 15 mm long. It is inequivalve, the right valve is very much larger and more convex than the left, which fits snugly into it, leaving a considerable margin of the right valve bare. The posterior margin is slightly truncate. Both valves of *Corbula gibba* are sculptured with coarse, concentric grooves and ridges, the left valve additionally having faint radiating lines. The beaks are turned inward and touching. The shell is dull white to cream, the interior is white with a faint pinkish or bluish tinge, sometimes with blotches of yellow. The pallial line is very faint and there is a slight posterior indentation or sinus.

Recorded distribution in Britain and Ireland

Common and widespread on all British coasts. The species is probably more widespread than mapped but records are not readily available.

Global distribution

Corbula gibba is distributed from the Norwegian Sea south to the Iberian Peninsula, into the Mediterranean and Black Seas, and along the coast of West Africa to Angola.

Habitat

Corbula gibba is found from the low shore to considerable depths in the sublittoral, living in muddy sand and gravel.

Depth range
ELW - 146 m

Identifying features

- The right valve is much larger and more convex than the left valve.
- The shell has a plump, broadly oval to triangular shape.
- The shell is up to 15 mm in length.
- Both valves are sculptured with coarse, concentric grooves and ridges, the left valve additionally having faint radiating lines.
- In front of the chondrophore of the left valve is a deep triangular pit into which a projecting cardinal tooth-like structure on the right valve fits.

Additional information
No text entered

Listed by

Further information sources

Search on:

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Biology review

Taxonomy

Phylum	Mollusca	Snails, slugs, mussels, cockles, clams & squid
Order	Myida	Gapers, piddocks, and shipworms
Family	Corbulidae	
Genus	Corbula	
Authority	(Olivi, 1792)	
Recent Synonyms	-	

Biology

Typical abundance	High density
Male size range	
Male size at maturity	
Female size range	Small(1-2cm)
Female size at maturity	
Growth form	Bivalved
Growth rate	See additional information
Body flexibility	None (less than 10 degrees)
Mobility	
Characteristic feeding method	Active suspension feeder, Active suspension feeder
Diet/food source	
Typically feeds on	Phytoplankton, diatoms and bacteria.
Sociability	
Environmental position	Infaunal
Dependency	-
Supports	-
Is the species harmful?	No

Biology information

Growth

Corbula gibba is a small bivalve mollusc. The growth rate of *Corbula gibba* is rapid during the first few months of its juvenile stage although it is very slow in adults (Jensen, 1990). In Nissum Bredning, Denmark the growth of juvenile *Corbula gibba* was rapid during their first two months (July-August) but leveled off in September and October at lengths ranging from 2.9-3.5 mm (Jensen, 1988). Thus juvenile *Corbula gibba* reached a size of 3 mm within the first 1-2 months after settling (Jensen, 1990). The absolute growth rate for that period was about 0.03 mm/day and remained constant until the end of August. No further growth was observed in September and October (Jensen, 1988). One year after juvenile settlement, specimens reached a mean size of 6 -7 mm. In the Limfjord (Denmark) it was suggested that the variation in growth rates was caused by variable frequencies of wind induced resuspension of settled organic matter. In the Limfjord wind speeds above Beaufort force 8 caused mixing of the water column and probably resuspension of bottom material in 1986. These conditions probably favour *Corbula gibba* as it is one of the most efficient bivalve particle feeders (Kiøboe & Mohlenberg, 1981). In 1985 the wind speeds never exceeded force 8 and no mixing was observed. This resulted in lower abundances of *Corbula gibba* and slower growth rates (Jensen, 1990).

Slower growth rates have been recorded in the Danish Sound where it took a population of *Corbula gibba* seven months to reach a mean size of 1.1 mm (Muss, 1973). Whereas in Port Erin on the Isle of Man it took one year for a population of juveniles to reach a mean size of 4 mm (Jones, 1956, Jensen, 1990). Jones (1956) also reported that the specimens of *Corbula gibba* on the Isle of Man had a modal length of 2.25 mm. Jensen (1990) suggested that the higher growth rates in the 1990's in Danish waters could be the result of specific events such as eutrophication. However, in Nissum Bredning no specimens were found over two years old in 1990. The size of *Corbula gibba* around the British Isles ranged from 0.5 mm in length to 1.2 cm in the 1940's (Yonge, 1946), and in Australian waters it can reach sizes up to 1.5 cm (CRIMP, 2000).

Abundance
Corbula gibba is often found in very large numbers and is often abundant in eutrophic areas (Pearson & Rosenberg, 1978). *Corbula gibba* are known to occur in enormous numbers, for instance 7450/m^2, at certain localities in the Atlantic (Healy & Lamprell, 1996). In the Limfjord, sampling of *Corbula gibba* was carried out at monthly intervals from April 1986 to May 1988. Ten samples were taken with a HAPS-corer (0.014 m^2) and sieved over a 1 mm sieve (Jensen, 1990). The density for *Corbula gibba* ranged from 9,000 to around 53,000 per m^2. Newly settled *Corbula gibba* ranged from 30,000 and 67,000 individuals per m^2 (Jensen, 1988). In Pula Harbour in the Northern Adriatic, *Corbula gibba* was found at densities ranging from 33 -121 individuals / 0.2 m^2 (Hrs-Brenko, 1981). *Corbula gibba* is also found in Australia, outside of its native range, at densities of up to 250/m^2 in Port Philip Bay (CRIMP, 2000).

Biomass / Production
During 1974-1984 nitrogen concentration and primary production of specimens of *Corbula gibba* in Nissum Bredning increased from 50-100 % and 200-300 %. The production (P) of *Corbula gibba* is generally high. Productivity was measured over two years and ranged from 0.7-72 g AFDW (ash free dry weight) m^2/ yr. with an average of 26.8g AFDW m^2 / yr. in Nissum Bredning. The production / biomass ratio was amongst the highest recorded with a mean P / B of 4:2 per year (Jensen, 1990).

Respiration
Laboratory studies have shown that *Corbula gibba* are able to survive long periods at near anoxic conditions. After 57 days, 9 out of 14 specimens survived 10 -11°C and oxygen levels of 0.18 to 0.37 mg oxygen per dm^3 (Christensen, 1970).

Burrowing
Corbula gibba is a shallow burrowing bivalve with very short siphons (Yonge & Thompson, 1976). When placed on their normal substratum, individuals extrude their thin long foot to a distance that may exceed the length of its shell (Yonge, 1946). The process of burrowing is very slow. For example, an individual 1 cm long took about 30 minutes to burrow below the surface. This is slow when compared to other bivalve species, for example *Abra alba* that can disappear below the surface in less than a minute. It is the stout rounded shell that makes slow progress into the substratum, whereas *Abra alba* has a much flattened shell and foot therefore slides quickly into the substrata (Yonge, 1946).

Predators
Corbula gibba is consumed by gastropods, crustaceans, fish and echinoderms. Predators of *Corbula*

gibba include the necklace shell *Natica poliana* (Jones, 1956), the sand star *Astropecten irregularis* (Christensen, 1970), the brittle star *Ophiura texturata*, the common starfish *Asterias rubens*, the common shore crab *Carcinus maenas* and the brown shrimp *Crangon crangon* (Jensen, 1988).

Non-native species
In Australia, *Corbula gibba* is an alien species and a pest (CRIMP, 2000). *Corbula gibba* is now widespread and highly abundant in Port Phillip Bay (Australia) (Talman, 1998; cited in Talman & Keough, 2001). *Corbula gibba* might affect endemic Australian species via habitat modification, predation on planktonic larvae, and competition. It also possesses a number of characteristics that may give it a competitive advantage over Australian endemic species, such as the capacity for fast growth and the ability to tolerate a wide range of environmental conditions including anoxia and eutrophication (Jensen, 1990; Talman & Keough, 2001). Concern has arisen in Australia regarding the impact of *Corbula gibba* on the commercial scallop *Pecten fumatus*. *Corbula gibba* and *Pecten fumatus* overlap in distribution, and as suspension feeders, it has been suggested that they utilize similar food and therefore may be competing for space and food (Talman & Keough, 2001). It was found that ambient densities of *Corbula gibba* had a significant impact on the size and growth of the native juvenile *Pecten fumatus* but not on mortality rates (Talman & Keough, 2001). Scallops in the presence of *Corbula gibba* had shells that were, on average, 35% lighter, 24% smaller and exhibited 54% less growth (based on caging experiments) (Talman, 2000: cited in NIMPIS, 2002). As a result of these concerns Australian authorities have developed new methods to control the spread of *Corbula gibba*. However, measures such as dredging / beam trawling / mopping, changing salinity and oxygen deprivation have all proved relatively unsuccessful (McEnnulty *et al.*, 2001a).

Habitat preferences

Physiographic preferences	Open coast, Offshore seabed, Strait / sound, Estuary, Enclosed coast / Embayment
Biological zone preferences	Lower circalittoral, Lower eulittoral, Lower infralittoral, Sublittoral fringe, Upper circalittoral, Upper infralittoral
Substratum / habitat preferences	Gravel / shingle, Mixed, Muddy gravel, Muddy sand, Sandy mud
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Strong 3 to 6 knots (1.5-3 m/sec.), Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Exposed, Moderately exposed, Sheltered, Very exposed, Very sheltered
Salinity preferences	Full (30-40 psu), Reduced (18-30 psu), See additional Information, Variable (18-40 psu)
Depth range	ELW - 146 m
Other preferences	
Migration Pattern	Non-migratory / resident

Habitat Information

Global distribution
Corbula gibba has spread and outside its native range. This species and its larvae can survive long periods in ballast water and can generate heavy or at least significant populations in foreign harbours. It is most likely that the presence of larvae in ballast water has resulted in the

introduction of *Corbula gibba* into Australian waters in Port Phillip Bay (McEnnulty *et al*., 2001b). Its occurrence in Port Phillip was the first documented record of the species outside its area of natural distribution (Talman & Keough, 2001). The clam has subsequently been found in Portland, Western Port Bay in Victoria, Devonport and the D'Entrecasteaux Channel in Tasmania (CRIMP, 2000).

Substrata
Corbula gibba is specialized for life in a substratum of muddy sand mixed with larger pieces of gravel and stone that are necessary for the planting of its single byssus thread (Yonge, 1946). This preference for muddy substrata was reported by Jones (1956). Jones (1956) recorded significant differences in the numbers of *Corbula gibba* between two sites in Port Erin on the Isle of Man. Higher numbers of *Corbula gibba* were recorded in areas of coarse muddy sand. In an area only 1/2 mile seawards from the previous site the sediments were fine and the numbers of *Corbula gibba* present were low (Jones, 1956). In the Adriatic *Corbula gibba* was completely absent in clean, sandy bottoms as it prefers some mud (Hrs-Brenko, 1981).

Preference for coarse muddy sand has also been seen in Port Philip Bay where *Corbula gibba* are rarely found in sediments that contain less than 10% mud (<63 µm). Below 15% mud there was a strong relationship between the percentage mud and the abundance of *Corbula gibba* (Parry & Cohen, 2001). Above 15 % mud there was no significant relationship between the abundance of *Corbula gibba* and percentage mud in the finer sediments (Parry & Cohen, 2001).

Water quality
Hrs-Brenko (1981) suggested that *Corbula gibba* thrives in eutrophic waters.

Salinity range
Corbula gibba has been recorded at the following salinities, 26 - 39 ppt in Port Phillip Bay (Talman, 2000: cited in NIMPIS, 2002), 28 - 34 ppt in Limfjord, Denmark, (Jensen, 1990), 27 - 32 ppt in Nissum Bredning, Denmark (Jensen, 1988) and 8.2-38.6 ppt in Elefsis Bay, Greece (Theodorou, 1994).

Life history

Adult characteristics

Reproductive type	Gonochoristic (dioecious)
Reproductive frequency	Annual protracted
Fecundity (number of eggs)	No information
Generation time	See additional information
Age at maturity	Insufficient information
Season	Summer - Autumn
Life span	1-2 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Planktotrophic

Duration of larval stage	See additional information
Larval dispersal potential	No information
Larval settlement period	Insufficient information

Life history information

Reproduction

Yonge (1946) determined that *Corbula gibba* was dioecious with no evidence of a sex change. When the gonads of *Corbula gibba* are maturing it is easy to distinguish between males and females. Males have white testes whereas females have pink ovaries (Yonge, 1946).
Reproduction and spawning generally occur during summer and autumn. Yonge (1946), observed that during early August the male gonads were filling but were not yet ripe and that the testes had developed further than the ovaries. There were however, no active sperm present. In late August, it was noted that in female *Corbula gibba* the ovaries were filling. No ripe sperm was found until the middle of September. By the end of September the male and female specimens were ripe. The ripe females had relatively large yolky eggs and ripe males had very active sperm (Yonge, 1946).

Fosshagen, (1965; cited in Muss, 1973) found larvae of *Corbula gibba* in plankton from October - November and once again from January - February and suggested that it was possible for large individuals to spawn during the autumn.

Larval Settling Time

The settling time of *Corbula gibba* larvae is variable depending on location and may take several months (Jensen, 1988). In Danish waters settlement occurred in August. (Jensen, 1988) states that the settlement of *Corbula gibba* is very distinct with very few specimens below 2 mm in size during the month of September in Limjford. The recruitment of *Corbula gibba* was achieved within one week after settlement (Jensen, 1988). However, high moralities of newly settled individuals occurred during the first month of settling. It was suggested that this was may be due to predation from epibenthic predators. Low and constant mortality occurred during the winter months with decreases in abundance again in spring and early summer. It was suggested that these observation could be due to the weakened conditions in the bivalves that had spawned (Jensen, 1988).

Longevity

Jensen (1990) suggested that the lifespan of *Corbula gibba* seems to be shorter at 1 -2 years in Nissum Bredning than in the first part of this century when individuals had a lifespan of 5 -6 years with a maximum size of 12 mm (Jensen 1919: cited in Jensen, 1990).

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	Moderate

Corbula gibba lives infaunally in muddy sandy sediments. Removal of the substratum would also remove the entire population of this species, and so the intolerance has been assessed to be high with a moderate recoverability. See additional information for recoverability.

Smothering	Low	Immediate	Not sensitive	Low

Corbula gibba is a burrower in shallow muddy or sandy sediments and uses a byssus thread to attach to pieces of shell or rock in the sediment (CRIMP, 2000). It uses its short inhalant siphon above the sediment for feeding and respiration. If smothered *Corbula gibba* would most likely burrow up through the new sediment. *Corbula gibba* is also considered to be generally tolerant of prolonged oxygen deprivation (see deoxygenation below). Laboratory studies on *Corbula gibba* have shown that they can survive up to 57 days in near anoxic conditions (Jensen, 1990). Therefore *Corbula gibba* could probably survive for 1 month under smothering conditions (see benchmark). However, sudden smothering of the sediment would halt feeding. Therefore, intolerance has been assessed as low with a immediate recoverability level.

Increase in suspended sediment	Tolerant*	Not relevant	Not sensitive*	Moderate

Levels of suspended sediment are likely to be most relevant to feeding. An increase in suspended sediment is likely to increase the rate of siltation and the availability of food. This will effect *Corbula gibba* as it is a suspension feeder. However, *Corbula gibba* is one of the most efficient bivalve particle feeders (Kiørboe & Mohlenberg, 1981). In the Limfjord, increased winds caused a greater mixing of the water column and probably greater resuspension of bottom material in 1986. As a result population increases were recorded with higher densities and faster growth than the previous year when wind speeds were not as high (Jensen, 1990). *Corbula gibba* also has a well developed cleansing mechanism to deal with the accumulation of pseudofaeces by posterior and periodic contractions of the quick muscle component in the adductors (Yonge & Thompson, 1976). An increase in sediment may benefit *Corbula gibba* and tolerant* has been recorded.

Decrease in suspended sediment	Low	Immediate	Not sensitive	Low

Levels of suspended sediment are likely to be most relevant to feeding. A decrease in suspended sediment is likely to decrease the availability of food for suspension feeders like *Corbula gibba*. Mortality is unlikely to occur within a month (see benchmark) but growth rates may be slower and so intolerance is assessed as low. When suspended sediment levels return to normal so to will food availability and recoverability is assessed as immediate.

Dessication	Low	Very high	Very Low	Low

The effect of desiccation stress on *Corbula gibba* is likely to be minimal as it lives infaunally in muddy sand and is able to burrow to avoid or reduce the effects of desiccation. Bivalves are also able to respond to desiccation stress by valve adduction during periods of emersion.

Nevertheless, some stress is likely and an intolerance of low has been recorded but with a very high recoverability.

Increase in emergence regime Intermediate High Low Low

An increase in emergence may cause thermal stress on *Corbula gibba* and increase the risk of dislodgement from the sediments because of the increased strength of wave action, especially in shallow water populations. Therefore, an intolerance of intermediate is given with a high recoverability.

Decrease in emergence regime Tolerant* Not relevant Not sensitive* Low

A decrease in emergence, is not likely to stress *Corbula gibba* and may benefit the species, allowing *Corbula gibba* to colonize further up the shore and increase its habitat range. Periods of thermal stress, risk of predation and dislodgement would be reduced. Therefore, tolerant* is recorded.

Increase in water flow rate Intermediate High Low Low

An increase in the water flow rate, would increase the availability of food that may increase growth rates and the size of individual *Corbula gibba*. However increased water flow may cause the substratum to be disturbed and the sediment on the seabed to erode. This scouring of sand and gravel causes coarse sediments to become unstable and difficult to burrow perhaps leading to the dislodgement and abrasion of *Corbula gibba*. The sediments and the species within may then be transported to another area. High water flow rates may also damage or prevent settlement of larvae that can lower recruitment levels and lower the population present (Hiscock, 1983). Therefore, an intolerance of intermediate has been assessed with high recoverability.

Decrease in water flow rate Intermediate High Low Low

A decrease in the water flow rate could result in a reduction in food that may be obtained from suspension feeding in *Corbula gibba*, which could lower growth rates and the sizes of individuals within the population. It may also lower the dispersion of planktonic larvae. In areas exposed to less water flow, the sediments will be more stable (Hiscock, 1983) and particles may become finer and the substratum may become more muddy which is the preferred substrata of *Corbula gibba*. However, a decrease in water flow over the benchmark level of 1 year may also cause the substratum to become too muddy for *Corbula gibba*, which prefers sediments that contain between 10 - 15 % mud (Parry & Cohen, 2001). Therefore, intolerance has been assessed as intermediate with a high recoverability level.

Increase in temperature Tolerant Not relevant Not sensitive Low

Corbula gibba is present in Mediterranean and Australian waters. Growth has been recorded at the following temperatures:

- 11.3 - 24.3 °C in Elefsis Bay, Greece (Theodorou, 1994);
- 9.18 - 21.45 °C in the Adriatic Sea (Moodley *et al.*, 1998);
- 8 - 26 °C in Port Phillip Bay (Talman, 2000; cited in NIMPIS, 2002).

Therefore, *Corbula gibba* has been assessed as tolerant to increases in temperature at the benchmark level.

Decrease in temperature Tolerant Not relevant Not sensitive

Corbula gibba has a wide geographic range, occurring in waters throughout the British Isles and is likely to be tolerant of lower temperatures than it experiences in Britain and Ireland. *Corbula gibba* would probably tolerate a decrease in temperature (see benchmark) as it has been found at temperatures between - 1 to 16 °C in the Limfjord (Jensen, 1990), and also at 7.5 °C in the Kattegat (Christensen, 1970). Therefore, *Corbula gibba* has been assessed to be tolerant to decreases in temperature.

Increase in turbidity Low Very high Very Low Low

Corbula gibba does not require light therefore, the effects of increased turbidity on light attenuation are not directly relevant. An increase in turbidity may however, affect primary production in the water column that would lower phytoplankton availability for *Corbula gibba*, as it is a suspension feeder, but it can use other food sources e.g. particulate organic matter. Therefore, intolerance has been assessed as low with a very high recoverability.

Decrease in turbidity Not relevant Not relevant Not relevant Low

Corbula gibba does not require light therefore, the effects of a decrease in turbidity on light attenuation are not directly relevant. A decrease in turbidity may however, affect primary production in the water column that would increase phytoplankton availability for *Corbula gibba*. That could improve growth rates of *Corbula gibba* and also increase their abundance. A decrease in turbidity is unlikely to affect *Corbula gibba*. Therefore not relevant has been recorded.

Increase in wave exposure Intermediate High Low Moderate

Corbula gibba inhabits coarse muddy / sandy environments. This preference for coarse muddy sands was observed offshore of Port Erin on the Isle of Man where significant differences in the numbers of *Corbula gibba* was recorded. In areas where the substratum was coarse, the numbers of *Corbula gibba* were abundant. Whereas in areas where the substratum was fine the abundance of *Corbula gibba* was low (Jones, 1956).
An increase in wave exposure is likely to change the nature of the sediment in shallow depths making it less muddy and less suitable for *Corbula gibba* . The dispersion and settlement of larval and juvenile stages may also be disrupted. Damage or the withdrawal of the siphons, which reduces the ability of *Corbula gibba* to feed could occur. Increased wave exposure may also be detrimental to predators of *Corbula gibba* and prevent them from feeding. Intolerance has been assessed as intermediate with a high recoverability.

Decrease in wave exposure Intermediate High Low Moderate

Changes in wave exposure are likely to have marked effects on the sediment dynamics. If the wave exposure is decreased sediments that are deposited will slowly consolidate becoming more fine and muddy and can increase the substratum. Decreased exposure could increase siltation and the risk of smothering. *Corbula gibba* is specialized for its preferred habitat of muddy sand, however a decrease in wave exposure over the benchmark period of 1 year may cause the substrata to become too muddy for *Corbula gibba*. Therefore, intolerance has been assessed as intermediate with a high recoverability.

Noise Tolerant Not relevant Not sensitive High

No information was found concerning the intolerance levels of *Corbula gibba* to noise. This species is not expected to be sensitive to the level of the benchmark.

Visual Presence Tolerant Not sensitive High

Corbula gibba probably has little visual acuity and was recorded to be not sensitive to this factor.

Abrasion & physical disturbance Intermediate High Low Moderate

Corbula gibba has a small solid shell. The shells of *Corbula gibba* may be vulnerable to physical

damage (from e.g. otter boards) (Rumohr & Krost, 1991). However, the size of *Corbula gibba* relative to the meshes of commercial trawls may ensure survival of a moderate proportion of disturbed individuals that pass through them. Specimens exposed on the sediment surface would be at risk of predation. Bergmann & van Santbrink (2000) reported direct mortalities of <0.5%, 9% and 14% from the passage of an experimental beam trawl, depending on the type of trawl used and sampling method employed. They noted that smaller species or smaller individuals of larger species suffered lower mortalities. Overall, they concluded that *Corbula gibba* was amongst the species studied that were relatively resistant to bottom trawling (Bergmann & van Santbrink, 2000).
Ball *et al.* (2000) noted that *Corbula gibba* was not found at their offshore experimental otter trawling site but was present at an untrawled, ship wreck site. In a further study in Loch Gareloch, *Corbula gibba* was identified as one of the species sensitive to fishing disturbance. The Gareloch study carried out otter trawls at monthly intervals for 16 months in a previously undisturbed area, sheltered sea loch. The experimental trawling resulted in changes in the sediment and the associated community due to increase in opportunistic polychaetes, resulting in a 45% decrease in the abundance of *Corbula gibba* with respect to reference sites. However, the Gareloch study represents a level of impact greater than the benchmark. Nevertheless, both of the experimental trawling studies result in mortality. Therefore, an intolerance of intermediate is recorded with a high recovery level.

Displacement	Intermediate	High	Low	Moderate

Fishing for demersal species will disturb the surface layer of sediment and any protruding or shallow burrowing species. The small size of *Corbula gibba* may ensure that individuals are sieved over the mesh of fishing nets. Once through the net *Corbula gibba* are then able to resettle in the substrata.

Displacement may also occur during storms if the sediment is mobilized. The increased wave action may cause whole populations to be lifted along with the substratum and transported by sediment bedload transport to a different area. *Corbula gibba* can burrow back down into the sediment when it is displaced to the surface therefore, it is probably relatively tolerant of displacement. However, it burrows slowly and when displaced the risk of predation by predators is increased which can lead to some mortalities of *Corbula gibba*. Therefore, an intolerance of intermediate has been recorded with a high recoverability.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	Intermediate	High	Low	Very low

No specific information was found concerning the effect of synthetic chemicals on *Corbula gibba*. However, inference may be drawn from related species. Burrowing and avoidance behaviour in the bivalves *Tellina tenuis* and *Limecola balthica* becomes impaired when they are exposed to phenol but no deaths occurred. Impairment of burrowing can leave bivalves vulnerable to predation and wave action (Møhlen & Kiørboe, 1983). High levels of tributyl tin (TBT), the toxic component of many antifouling paints, has been implicated in the slow growth and shell malformation 'balling' in the oyster *Magallana gigas* and larval mortality in *Mytilus edulis* (Beaumont *et al.*, 1989). Overall, an intolerance of intermediate has been suggested, albeit with very low confidence.

Heavy metal contamination	Intermediate	High	Low	Moderate

Heavy metals can inhibit the activity of many enzymes and affect the function of several cellular constituents such as membranes, they can also inhibit growth, the production of the byssal thread, respiration, filtration rate, protein synthesis, the uptake of amino acids by various tissues and compromise reproduction in bivalves (full review by Aberkali & Trueman, 1985). The embryonic and larval stages of bivalves are the most vulnerable to heavy metals (Bryan, 1984).

Bryan (1984), states that Hg is the most toxic metal to bivalve molluscs in experimental studies while copper (Cu), cadmium (Cd) and zinc (Zn) seem to be most problematic for bivalves in the field. For example:

- exposure to 15 parts per billion (ppb) of copper was found to produce deformed embryos in *Crassostrea virginica*and 33 ppb proved lethal to their larvae (Bryan, 1984). The adults, on the other hand can withstand exposure to such levels although, through the immobilization of copper, they become green and unpalatable (Bryan, 1984);
- exposure to 100 ppb of cadmium for 15 weeks induced poor conditions and mortalities in adult *Crassostrea virginica* (Bryan, 1984).

Rygg (1985) used 71 sampling stations in a dozen fjord areas with varying degrees of pollution to examine the effects of pollution on benthic fauna. He noted that benthic faunal biodiversity decreased with increasing Cu concentrations in the sediment. *Corbula gibba* was reported to be present at some but not all of the stations where sediment copper concentrations were above 200 ppm in the sediments and was classified as one of the moderately tolerant species (Rygg, 1985). A concentration of 200 ppm was approximately 10 tens background values (Rygg, 1985). *Corbula gibba* was more tolerant than the bivalves, *Ennucula tenuis*, which was absent at all the sampling stations and *Thyasira equalis*, which was occasionally present at the sampling stations (Rygg, 1985). Overall, an intolerance of intermediate has been recorded, since *Corbula gibba* was exclude from some of the polluted sites examined..

Hydrocarbon contamination Not relevant

Hydrocarbons may produce substantially reduced feeding, respiration and energy metabolism rates that reduce growth and reproduction as observed in *Mya arenaria* (Cooper & Cristini, 1994) and *Mytilus edulis* (Moore *et al*., 1987). Reproduction may also be compromised on exposure to hydrocarbons, for example *Limecola balthica* showed gamete resorption and abnormal gamete development. Additional effects of hydrocarbons on bivalves include a decline in tissue and shell growth, increased susceptibility to predation, parasitism and disease (Moore *et al*., 1987).

However, oil spills may benefit some bivalve molluscs. For instance, the 1978 Amoco Cadiz oil spill may have benefited the population of *Abra alba* present due to the nutrient enrichment that was caused by the oil spill. The biomass of the community doubled as a result of an increase in *Abra alba* abundance following the oil spill. Throughout the 20 years of monitoring the community's recovery, *Abra alba* has been one of the dominant species recorded (Dauvin, 1998). *Corbula gibba* has been noted as being indifferent to organic pollution (Pearson & Rosenberg, 1978) and has been recorded to often thrive in nutrient enriched waters (Crema *et al*., 1991) (see nutrients below). However, no information on the effects of hydrocarbon contamination on *Corbula gibba* was found, and intolerance has not been assessed.

Radionuclide contamination Not relevant

No specific information was found concerning the effects of radionuclides on *Corbula gibba*.

Changes in nutrient levels Tolerant* Not relevant Not sensitive* Moderate

Corbula gibba is known to be a pioneer species in recolonization of defaunated seabeds and prominent in sub normal zones in areas polluted or enriched by organic material (Pearson & Rosenberg, 1978; Jensen 1990). It has also been suggested that *Corbula gibba* are indicative of unstable environments such as ones with low oxygen levels and areas of eutrophication (Crema *et al.*, 1991). For example, samples were taken of the macrozoobenthic community in Elefsis Bay in the northern Adriatic in 1985. Elefsis Bay suffered from nutrient enrichment where nutrient pollution mainly came from the disposal of untreated waste waters of about 600,000 m□ / day at the entrance of the bay. The major nutrient inputs recorded were from phosphates, silicates, nitrites, nitrates and ammonium. Eutrophication of the northern Adriatic Sea was marked by red tides, extensive mucus aggregates, anoxic bottom conditions and mass mortalities. Despite this anoxia, large abundance's of *Corbula gibba* were recorded. The abundance of *Corbula gibba* at one sampling station was 1396 ind/m□ and during the summer of 1989 *Corbula gibba* was the only living species recorded (Theodorou, 1994). Nutrient enrichments appear to benefit *Corbula gibba* by allowing it to increase its population size and to further colonize an area. It was suggested that as the amount of organic material reaching sediments increases, the larger species and deeper burrowing species are gradually eliminated and replaced by greater numbers of bivalves like *Corbula gibba* (Pearson & Rosenberg, 1978). Therefore, nutrient enrichment may benefit *Corbula gibba* and tolerant* has been recorded.

Increase in salinity Tolerant Not relevant Not sensitive Very low

Corbula gibba are mainly found at oceanic salinities but have also been recorded in 26 - 39 ppt in Port Phillip Bay (Talman, 2000: cited in NIMPIS, 2002). Therefore, it is likely that Corbula gibba would tolerate an increase in salinity at the benchmark level.

Decrease in salinity Tolerant Not relevant Not sensitive

Corbula gibba are found at oceanic salinities and in estuarine waters showing a tolerance for a reduction in salinity. In Elefsis Bay, *Corbula gibba* can be found at salinities as low as 8.2 ppt (Theodorou, 1994). Therefore *Corbula gibba* is likely to be tolerant of decreases in salinity.

Changes in oxygenation Low Immediate Not sensitive Moderate

Diaz & Rosenberg (1995) state that *Corbula gibba* is resistant to severe hypoxia. *Corbula gibba* is often found at the edge of anoxic and azoic areas (Pearson & Rosenberg, 1978) and it has been suggested that it is highly tolerant to environmental variability (Rosenberg, 1997).

- In the western trough of Lough Ine in Ireland, a summer thermocline develops and the oxygen content falls. Oxygen levels were so low that the muddy substrata turned black. During the summer months, no species were found below 40 m except for *Corbula gibba* and it was reported to be the most hypoxic tolerant species in the Lough. However, by autumn no macrofauna and no populations of *Corbula gibba* were present in the Lough as conditions became too hypoxic (Kitching *et al.*, 1976).
- The Little Belt near the coast of Denmark showed diminishing oxygen concentrations in the bottom waters that resulted in a 5 fold increase of areas with oxygen depletion. A decline in species sensitive to oxygen declines was found. Whereas, those species that were less sensitive to oxygen depletion for example *Corbula gibba* increased by a factor of two to five times (from about 400 - 500 ind.□ to > 2000 ind.m□) (Karlson *et al.*, 2002).
- Kiel Bay in the Baltic Sea has also seen significant declines in deep water oxygen concentration since the 1950's. In 1981 the salinity was 20-26 psu, and temperatures of 10-14°C were recorded. Anoxia and hydrogen sulphide were widespread below the halocline at a depth of >20 m (Rosenberg & Loo, 1988). The anoxic event lasted several weeks and during that time, 30,000 t of macrofauna was lost over 750 km□. *Corbula gibba* was one of the few species that survived this event.

- Another area that has recorded severe hypoxic events is Kattegat, Sweden. The worst year recorded was 1988, when approximately 30,000 km▯ of the bottom water was hypoxic. Oxygen concentration recorded were 3.1 ml/l in June, 1.0 ml/l in August, 0.9 ml/l in September, and *Corbula gibba* was amongst the surviving species.
- Laboratory studies have shown that specimens of *Corbula gibba* were able to survive long periods of near anoxic conditions. Results showed that 9 out of 14 specimens survived after 57 days at anoxic conditions (10 - 11 °C and 0.18 - 0.37 mg of oxygen per dm ▯) (Jensen, 1990).

Corbula gibba has shown tolerance to severe decreases in oxygenation therefore, an intolerance assessment of low has been given with a recoverability assessment of immediate.

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of microbial pathogens/parasites	Low	Very high	Very Low	Low

The ciliate *Sphenophrya dosiniae* has been found living in specimens of *Corbula gibba*. If a lamellibranch is infected with *Sphenophrya dosiniae*, the ciliates will always occur in great numbers in the mantle cavity of their host (Fenchel, 1965). *Sphenophrya dosiniae* was found in 40 % of the specimens of *Corbula gibba* in the Gullmarfjord (Fenchel, 1965). No specific information concerning the effects of these ciliates on *Corbula gibba* was found.

However, in the bivalve *Crassostrea virginica*, *Sphenophrya dosiniae* induced the formation of a lump known as a 'xenoma' that contains hundreds of ciliates (Weissenberg, 1922; cited in Laucker, 1983). Neither the ciliates or the xenomas appeared to distress *Crassostrea virginica*. However, parasitic infections are likely to result in sub-lethal effects and an intolerance of low has been recorded with a very high recoverability.

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of non-native species				Low

There is no evidence of adverse effects or competition from non-native species on *Corbula gibba*. Therefore, an intolerance and recoverability assessment could not be made.

	Intolerance	Recoverability	Sensitivity	Confidence
Extraction of this species	Not relevant	Not relevant	Not relevant	Low

Corbula gibba are not targeted for extraction. Therefore, an intolerance assessment is not relevant.

	Intolerance	Recoverability	Sensitivity	Confidence
Extraction of other species	Intermediate	High	Low	Moderate

Bergmann & van Santbrink (2000) reported direct mortalities of <0.5%, 9% and 14%from the passage of an experimental beam trawl, depending on the type of trawl used and sampling method employed. They noted that smaller species or smaller individuals of larger species suffered lower mortalities. Overall, they concluded that *Corbula gibba* was amongst the species studied that were relatively resistant to bottom trawling (Bergmann & van Santbrink, 2000). However, Ball *et al.* (2000) noted that *Corbula gibba* was not found at their offshore experimental otter trawling site but was present at an untrawled, ship wreck site. In a further study in Loch Gareloch, *Corbula gibba* was identified as one of the species sensitive to fishing disturbance. The Gareloch study carried out otter trawls at monthly intervals for 16 months in a previously undisturbed area, sheltered sea loch. The experimental trawling resulted in changes in the sediment and the associated community due to increase in opportunistic polychaetes, resulting in a 45% decrease in the abundance of *Corbula gibba* with respect to reference sites. *Corbula gibba* can burrow back down into the sediment when it is displaced to the surface but burrows slowly. While displaced onto the sediment surface the risk of predation by predators is increased which can lead to additional mortalities of *Corbula gibba*. Therefore, an intolerance of intermediate has been recorded. *Corbula gibba* has also been found to dominate during the first stages of post dredging recolonization (Talman & Keough, 2001). Therefore, recovery is likely to be rapid.

Additional information

Recoverability

The life span for individuals of *Corbula gibba* is about 1 -2 years (CRIMP, 2000). It has a rapid growth rate in the first few months of its life and the ability to survive in a wide range of environmental conditions and the capacity to achieve high population densities (Jensen, 1990). The settling time of *Corbula gibba* larvae is variable and may change depending on location and may take several months (Jensen, 1988). In Danish waters there were high moralities of newly settled individuals during the first month of settling. It was suggested that this was maybe due to predation from epibenthic predators (Jensen, 1988). Jensen (1988) reported that the survival rate of juveniles was around 19 -31% in Limjford). This was followed by low and constant mortality during the winter months and decreases in abundance again in spring and early summer. Jensen (1988) suggested that it could be due to the weakened conditions in the bivalves that had spawned. Despite the juvenile mortalities, high densities of adult *Corbula gibba* still occurred as *Corbula gibba* can produce a large number of eggs. Jensen (1988), stated that in Danish waters the recruitment of *Corbula gibba* was achieved within one week after settlement.

Recruitment may be sporadic, and prolonged long term variations in the abundance of *Corbula gibba* have been reported. For example, a high abundance of *Corbula gibba* was recorded (about 1,500 $/m^2$) between 1910 and 1935. This was followed by a constant low abundance (about 100 $/m^2$) until 1952, when abundances rose again (Jensen, 1988).

Corbula gibba is known to be a pioneer species in recolonization of defaunated seabeds and the species is abundant in sub normal zones in areas polluted or enriched by organic material (Pearson & Rosenberg, 1978; Jensen, 1990). Overall it is likely that this species has good powers of population recovery. A population that is reduced in extent or abundance could potentially recover within a few years, depending on recruitment. Its ability to recolonize defaunated area suggests that the population would recover is a relatively short period of time even if the population was removed.

Importance review

Policy/legislation

- no data -

Status

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

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

Supports which species

Rasmussen (1973), suggests that *Corbula gibba* are important as food for eels and flatfishes in Danish waters and may form part of the food of young fish.

Introduction of *Corbula gibba* to Australian waters.

Corbula gibba is an alien species and a pest (CRIMP, 2000) in Australian waters. *Corbula gibba* is now widespread and highly abundant in Port Phillip Bay, (Australia) (Talman, 1998; cited in Talman & Keough, 2001). *Corbula gibba* possesses a number of characteristics that may give it a competitive advantage over Australian endemic species, such as the capacity for fast growth and the ability to tolerate a wide range of environmental conditions including anoxia, and eutrophication (Jensen, 1990; Talman & Keough, 2001). Concern has arisen in Australia for one native species the commercial scallop *Pecten fumatus*. *Corbula gibba* and *Pecten fumatus* overlap in distribution, and as suspension feeders they presumably utilize similar food.

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