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

A brittlestar (*Amphiura filiformis*)

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

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Close up of arms and disc of *Amphiura filiformis*.
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Researched by	Jacqueline Hill & Emily Wilson	**Refereed by**	Dr Mattias Sköld
Authority	(O.F. Müller, 1776)		
Other common names	-	**Synonyms**	-

Summary

Description

A small brittle star, disc up to 10 mm in diameter, with very long arms (10x disc diameter) which lives buried in muddy sand. The dorsal side of the disc is covered with fine scales but the ventral side is naked. It is red-grey in colour. *Amphiura filiformis* extends its arms vertically 3-4cm into the water current to feed, in contrast with the deposit feeding *Amphiura chiajei* with which it is often found.

Recorded distribution in Britain and Ireland

Most British and Irish coasts although records have not been found for the south east of England.

Global distribution

Western Norway to the Mediterranean.

Habitat

Lives buried in the surface of fine muddy sands, mostly at depths greater than 15 m although can be found at extreme low water.

Depth range

15-100 m

Identifying features

- Disc up to 10 mm diameter, red-grey in colour, covered with fine scales, not extending to ventral inter-radii.
- Buried in mud or fine sand.
- Underside of disc naked, upper side covered with fine scales.
- No tentacle scales.
- 5-7 arm spines, the second from below is flattened and axe-shaped.

Additional information

No text entered

Listed by

Further information sources

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Biology review

Taxonomy

Phylum	Echinodermata	Starfish, brittlestars, sea urchins & sea cucumbers
Class	Ophiuroidea	Brittlestars
Order	Ophiurida	
Family	Amphiuridae	
Genus	Amphiura	
Authority	(O.F. Müller, 1776)	
Recent Synonyms	-	

Biology

Typical abundance	See additional information
Male size range	Disc diameter up to ca. 10mm
Male size at maturity	Disc diameter ca. 4mm
Female size range	Disc diameter ca. 4mm
Female size at maturity	
Growth form	Radial
Growth rate	0.20-1.67% body wt/day
Body flexibility	High (greater than 45 degrees)
Mobility	
Characteristic feeding method	Active suspension feeder, Passive suspension feeder, Surface deposit feeder
Diet/food source	
Typically feeds on	Plankton and detritus.
Sociability	
Environmental position	Infaunal
Dependency	Independent.
Supports	Host symbiotic sub-cuticular bacteria.
Is the species harmful?	No

Biology information

- **Typical abundance:** High density populations (i.e. higher than an arbitrary figure of 150/m^2) of *Amphiura filiformis* are common in the north east Atlantic Ocean and occur in sediments having silt/clay levels of about 10 to 20%. For example, in Galway Bay, Ireland, populations studied over an 8 year period had a maximum of 904 individuals per m^2 (O'Connor *et al*., 1983). Low density populations also occur along the north west European coastline.
- **Size:** Sizes at maturity given are from a population of *Amphiura filiformis* studied in Galway Bay, Ireland (O'Connor *et al*., 1983). Sköld *et al.* (2001) reported similar sizes. The disc diameter of *Amphiura filiformis* shows annual increases and decreases associated with sexual maturity. Maximum size is attained in August, just prior to gamete release and is

followed by a decrease in mean size (O'Connor *et al.*, 1983).
- **Growth rate:** Muus (1981) reported that newly settled recruits have a disc diameter of 0.3 mm and that they take 2 years to reach a size of 1.3 mm. However, Sköld *et al.* (2001) suggested that after 2 years, a disk size of ca 4 mm (concomitant with adult size and hence sexual maturity) could be attained. Josefson (1995) estimates the main part of disc growth occurs within the first 5 to 7 years of life. Sköld *et al.* (2001) studied post-larval recruits in the Gullmarsfjord and reported an asymptotic sigmoidal growth pattern for *Amphiura filiformis* (when growth data for adults and juveniles were combined). Specific growth rates of the post-larval settlers was 0.42% per day (disk diameter) and 1.76% per day (mean arm length) Sköld *et al.* (2001). Somatic and germinal growth rates may be enhanced by, for example, nutrient enrichment (Sköld & Gunnarsson, 1996) or temperature (see sensitivity section).
- **Feeding method:** *Amphiura filiformis* feed on suspended material in flowing water, but will change to deposit feeding in stagnant water or areas of very low water flow (Ockelmann & Muus, 1978). Suspension feeding capability is attained after about one year, at which point juveniles experienced exponential growth rates (Sköld *et al.*, 2001).

Habitat preferences

Physiographic preferences	Offshore seabed, Sea loch / Sea lough, Enclosed coast / Embayment
Biological zone preferences	Lower circalittoral, Lower infralittoral, Sublittoral fringe, Upper circalittoral, Upper infralittoral
Substratum / habitat preferences	Muddy sand, Sandy mud
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Extremely sheltered, Sheltered, Very sheltered
Salinity preferences	Full (30-40 psu)
Depth range	15-100 m
Other preferences	No text entered
Migration Pattern	Non-migratory / resident

Habitat Information

Possible density dependent migration where migration occurs on or in the sediment. Burrowing through the sediment takes longer but the risk of predation is decreased.

Life history

Adult characteristics

Reproductive type	Gonochoristic (dioecious)
Reproductive frequency	Annual protracted
Fecundity (number of eggs)	10,000-100,000
Generation time	Insufficient information
Age at maturity	3-4 years
Season	June - September

Life span	10-20 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Planktotrophic
Duration of larval stage	1-6 months
Larval dispersal potential	Greater than 10 km
Larval settlement period	See additional information

Life history information

- **Lifespan**
  Muus (1981) estimates the lifespan of the species to be 25 years based on oral width (which does not change with gonadial growth) to determine the stability of population structure, with recruitment taking place at the 0.3mm size levels. In very long-term studies of *Amphiura filiformis* populations in Galway Bay O'Connor *et al.* (1983) indicate a lifespan of some 20 years is possible. Sköld *et al.* (1994) also estimated a similar lifespan for the species in the Skagerrak, west Sweden. However, early suggestions for the lifespan of *Amphiura filiformis* had been estimated at between 2 and 6 years (Buchanan, 1964; O'Conner & McGrath, 1980; Ocklemann & Muus, 1978). These early estimates of the lifespan of ophiuroids were based on several factors which have been found to give a possible margin for error (Muus, 1981). Firstly, disc diameter had traditionally been used as the basis for population structure determination. However, this introduces a margin of error because gonadial growth causes disc diameter to increase during the breeding season and decrease after spawning. Secondly, most estimates were based on recruitment of individuals at a disc size of around 1mm so that sieving on a 1mm mesh did not retain the earliest settlers which were smaller.
- **Fecundity**
  A total of 50,000 oocytes per ripe female is reported by O'Connor (pers. Comm. In Duineveld *et al.*, 1987).
- **Gametes**
  Time of first and last gametes recorded is from Galway Bay, Ireland (Bowmer, 1982). A discrete, relatively short annual breeding period (Jun-Sep) was observed with peak activity in August. In the same area O'Conner & McGrath (1980) observed that all large animals spawned during August/September in two consecutive years. Buchanan (1964) reported that *Amphiura filiformis* breeds in July in Britain. In the Ligurian Sea in the Mediterranean the spawning period is much longer, lasting from March to November (Pedrotti, 1993).
- **Recruitment**
  Descriptions of the life history of *Amphiura filiformis* vary greatly in the literature. In most of these studies, the basis for determining the size of recruits, and therefore periods of recruitment, growth rates and lifespan, has been the mesh size used during sampling operations. The most commonly used mesh size, 1mm, has therefore not sampled the earliest settlers. For example, in a study of *Amphiura filiformis* populations in Galway Bay over a period of 2 years O'Conner & McGrath (1980) were not able to identify discrete periods of recruitment. However, other studies suggest autumn recruitment (Buchanan, 1964) and spring and autumn (Glémarec, 1979). Using a 265µm mesh size Muus (1981)

identified a peak settlement period in the autumn with a maximum of 6800 recruits per m^2. Sköld *et al.* (2001) reported settling densities of 7,100 - 7,400 per m^2 in October in the Gullmarsfjord. Muus (1981) shows the mortality of these settlers to be extremely high with less than 5% contributing to the adult population in any given year. In Galway Bay populations, small individuals make up ca. 5% of the population in any given month, which also suggests the actual level of input into the adult population is extremely low (O'Connor *et al.*, 1983).

- **Dispersal potential**
  After cold winter related mass mortality of *Amphiura filiformis* in the German Bight, Gerdes (1977) calculated that dispersal to a location 10km away was within the reach of the larvae. However, dispersal is largely determined by water movements and currents. The species is thought to have a long pelagic life. Sköld *et al.* (1994) estimated the time lag between full gonads and settlement to be 88 days. This duration is comparable to the time period when pelagic larvae have been recorded in the plankton from July to November in one study and August to December in another (Sköld *et al.*, 1994).

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	Moderate	Moderate	Moderate

Amphiura filiformis is an infaunal species and therefore substratum loss would result in mortality. Recoverability is considered to be moderate - see additional information for rationale.

Smothering	Low	Very high	Very Low	High

Amphiura filiformis is an infaunal species which can burrow and lives up to a depth of 4cm within the sediment. Therefore, smothering by sediment of 5 cm is unlikely to have great effect although feeding and hence viability of the population may be reduced if the sediment is particularly fine and mobile. Since only sub-lethal effects are likely intolerance is considered to be low. Smothering by impermeable materials, such as oil, is likely to result in death. Recovery is likely to be rapid as individuals move up through the sediment to resume their position for feeding and any fine particles are removed.

Increase in suspended sediment	Low	Very high	Very Low	Moderate

Amphiura filiformis is a passive suspension feeder. Increases in siltation of inorganic particles may interfere with the feeding of this species. However, the species live in burrows maintained by mucus so *Amphiura filiformis* can tolerate slight increases in siltation by removing an excess of particles with mucus production. On the Northumberland coast *Amphiura filiformis* is abundant in an area close to a rich supply of fine sediment from coastal erosion and run-off (Buchanan, 1964). The supply is sufficient enough to produce a covering of fine silty sediment. Intolerance to siltation is therefore low. On return to normal conditions recovery is likely to be rapid.

Decrease in suspended sediment	Tolerant	Not relevant	Not sensitive	Moderate

A decrease in the siltation of inorganic food particles may be of benefit to *Amphiura filiformis*. It would mean that the relative concentrations of organic material in suspension would be higher, possibly resulting in more efficient feeding. Not sensitive has been suggested.

Dessication	Low	Very high	Very Low	Moderate

Amphiura filiformis occurs at the infralittoral fringe and in the circalittoral zone (below 15 m) and so is not normally subject to desiccation stress which suggests the species would be intolerant of the factor. However, if desiccation were to increase the species is a mobile infaunal crawler and should be able to move to avoid the factor so intolerance is reported to be low.

Increase in emergence regime	Low	Very high	Very Low	Moderate

Amphiura filiformis occurs at the infralittoral fringe and in the circalittoral zone (below 15 m) and so is not normally subject to emergence. However, if the emergence regime were to change the species is a mobile infaunal crawler and should be able to move to avoid the factor so intolerance is reported to be low.

Decrease in emergence regime Tolerant Not relevant Not sensitive Moderate

Amphiura filiformis occurs at the infralittoral fringe and in the circalittoral zone (below 15 m). Therefore it will be tolerant of a decrease in emergence.

Increase in water flow rate High Moderate Moderate Moderate

As a suspension feeder without any self-produced feeding current, water flow rate will be of primary importance. Individuals respond rapidly to currents by extending their arms vertically to feed. Under laboratory conditions individuals would be unlikely to maintain this position if water movement were to increase to strong (3-6 knots) and so would retract their arms (Buchanan, 1964). A long term increase in water flow rate is also likely to change the nature of the sediment removing finer particles. High density aggregations of *Amphiura filiformis* seem to be characteristic of fine sediments with silt/clay values of 10 to 20% (O'Conner *et al*., 1983) so removal of the finer matter is likely to reduce abundance. Therefore, if water flow rate changes by the benchmark level of two categories for a year feeding would be significantly impaired and viability of the population reduced. Over the period of a year many individuals would be likely to die so intolerance is assessed as high. In some circumstances some animals may be able to move to unaffected areas. On return to normal conditions immigration of adults may occur but recovery through re-colonization by pelagic larvae is highly variable and may take several years and so recoverability is set at moderate. See additional information for full rationale.

Decrease in water flow rate Tolerant Not relevant Not sensitive Moderate

As a suspension feeder without any self-produced feeding current, water flow rate will be of primary importance. Individuals respond rapidly to currents by extending their arms vertically to feed. Under laboratory conditions they were shown to maintain this vertical position at currents of 30 cm/s (approx. 0.6 knots) (Buchanan, 1964). *Amphiura filiformis* feed on suspended material in flowing water, but will change to deposit feeding in stagnant water or areas of very low water flow (Ockelmann & Muus, 1978). Sediments may become muddier due to increased settlement of silt if current strength declines. However, at the level of the benchmark it is not expected that populations will be affected and *Amphiura filiformis* has been assessed to tolerate a decrease in water flow rate.

Increase in temperature Low High Low Moderate

The species is distributed in waters to the north and south of the Britain and Ireland and so is probably able to tolerate a long term change in temperature of 2 °C. In Galway Bay long term recordings of water temperature at a site of high density aggregations of *Amphiura filiformis* showed the species is subject to annual variations in temperature of about 10 °C (O'Connor *et al*., 1983). Increases in temperature may affect growth and fecundity. Muus (1981) showed that juvenile *Amphiura filiformis* are capable of much higher growth rates in experiments with temperatures between 12 and 17°C. Juvenile disk diameter increased from 0.5 to 3.0mm in 28 weeks under these conditions compared to over 2 years in the North Sea (Duineveld & Noort van, 1986). As the species appears to be killed only by extreme increases in temperature, an intolerance of low has been suggested. Recovery of normal growth rates and fecundity will be rapid on return to pre-impact temperatures and so recoverability is set to high.

Decrease in temperature Low High Low Moderate

The species is distributed in waters to the north and south of the Britain and Ireland and so is probably able to tolerate a long term change in temperature of 2 °C. In Galway Bay long term recordings of water temperature at a site of high density aggregations of *Amphiura filiformis* showed the species is subject to annual variations in temperature of about 10 °C (O'Connor *et al.*, 1983). However, echinoderms, including *Amphiura filiformis*, of the North Sea seem periodically affected by winter cold. A population at 27 m depth off the Danish coast was killed by the winter of 1962-63 (Muus, 1981) and a population at 35-50 m depth in the inner German Bight was killed in the winter of 1969-1970 and a new population not re-established until 1974 (Gerdes, 1977). Ursin (1960, cited in Gerdes, 1977) suggests that *Amphiura filiformis* does not occur in areas with winter temperatures below 4 °C although in Helgoland waters can tolerate temperatures as low as 3.5 °C. Low temperatures are a limiting factor for breeding which takes place during the warmest months in the UK. As the species appears to be killed only be extreme temperatures, intolerance is recorded as low. Recovery of normal growth rates and fecundity will be rapid on return to pre-impact temperatures and so recoverability is set to high.

Increase in turbidity	Low	Very high	Very Low	High

Amphiura filiformis is likely to have poor facility for perception of irradiance and consequently is probably not sensitive to changes in turbidity. However, one of the main food source of this species is phytoplankton that does have a requirement for light. Increases in turbidity may limit the amount of phytoplankton available to the brittlestars. In the very long term this would probably reduce growth and fecundity and hence the viability of the population. However, *Amphiura filiformis* can go for periods without food and at the benchmark level of turbidity effects should not be significant. Also food supplies are also likely to come from distant sources unaffected by local changes in turbidity. Intolerance is therefore, considered to be low. On return to normal conditions recovery is likely to be very high as increased light results in more photosynthetic productivity and improved food supply.

Decrease in turbidity	Tolerant	Not relevant	Not sensitive	Moderate

Amphiura filiformis is likely to have poor facility for perception of irradiance and consequently is probably not sensitive to changes in turbidity. However, one of the main food source of this species is phytoplankton that does have a requirement for light. Decreased turbidity may enhance phytoplankton production which may result in an enhances food supply. Tolerant has been suggested with moderate confidence.

Increase in wave exposure	High	Moderate	Moderate	Moderate

Amphiura filiformis is found in sheltered habitats characterised by fine muddy sandy sediments and low wave exposure. The species is likely to be intolerant of increases in wave exposure because strong wave action can resuspend the sediment and break up and scatter *Amphiura filiformis*. However, the species is able to burrow further into the sediment and if displaced is able to reburrow. Nevertheless, intolerance to wave exposure at the benchmark level is likely to be high because the species would probably not survive the disturbance for a period of a year. Recovery within five years may be possible as recolonization can take place from recruitment of larvae and juveniles and also immigration of adults from unaffected areas however recruitment is very sporadic and so recoverability is set to moderate - see additional information for full rationale.

Decrease in wave exposure	Not relevant	Not relevant	Not relevant	Not relevant

Amphiura filiformis is found in sheltered habitats characterised by fine muddy sandy sediments and low wave exposure. Thus an assessment for a decrease in wave exposure was not considered relevant.

Noise	Low	Immediate	Not sensitive	Moderate

Amphiura filiformis can withdraw its arms into its burrow when disturbed by noise vibrations in the surrounding water. At the benchmark level effects are likely to be minimal and so intolerance is recorded as low. If disturbed feeding would resume as soon as conditions were favourable and so recovery would be immediate.

Visual Presence	Tolerant	Not relevant	Not sensitive	Moderate

Amphiura filiformis is likely to have poor facility for visual perception and consequently is probably not sensitive to visual disturbance.

Abrasion & physical disturbance	Low	Very high	Very Low	Moderate

Brittlestars have fragile arms which are likely to be damaged by abrasion or physical disturbance. *Amphiura filiformis* burrows in the sediment and extends only its arms when feeding. Ramsay *et al.* (1998) suggest that *Amphiura* spp. may be less susceptible to beam trawl damage than other species like echinoids or tube dwelling amphipods and polychaetes. For example, Bergman & Hup (1992) found that beam trawling in the North Sea had no significant direct effect on small brittle stars. Brittlestars can tolerate considerable damage to arms and even the disk without suffering mortality and are capable of arm and even some disk regeneration. Intolerance to abrasion and disturbance is therefore recorded as low. Individuals can still function whilst regenerating a limb so recovery will be rapid.

Displacement	Low	Immediate	Not sensitive	High

Although not highly active, *Amphiura filiformis* is a crawling, burrowing, infaunal species. Following displacement individuals could crawl or burrow through sediment (Rosenberg *et al.*, 1997) until a suitable site is found. Burrowing through sediment may take more time and energy but predation risks are decreased. Individuals can right themselves if displacement caused them to be inverted and they can rapidly burrow into the sediment. Therefore, intolerance to displacement is low and recovery is immediate.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	High	Moderate	Moderate	Low

Echinoderms tend to be very sensitive to various types of marine pollution (Newton & McKenzie, 1995) and so an intolerance assessment of high is reported. A study of the influence of TBT on arm regeneration in another brittle star *Ophioderma brevispina*, revealed some evidence of inhibition at 10ng/l and significant inhibition at 100 ng/l. It is suggested that TBT acts via the nervous system, although direct action on the tissues at the point of breakage could not be excluded. If populations are lost recovery is moderate - see additional information.

Heavy metal contamination	Intermediate	High	Low	Low

Information about the effects of heavy metals on echinoderms is limited and no details specific to *Amphiura filiformis*, or any other brittlestars, were found. However, Bryan (1984) reports that early work has shown that echinoderm larvae are intolerant of heavy metals, e.g. the intolerance of larvae of *Paracentrotus lividus* to copper (Cu) had been used to develop a water quality assessment. LC_{50} concentrations exceeding 0.1 mg Cu L^{-1}, 1 mg Zn L^{-1} and 10 mg Cr L^{-1} for a duration between 4 -14 days of exposure have been reported for echinoderm species (Table 5.12, Crompton, 1997). As some mortality is reported, intolerance is assessed as intermediate. Adult echinoderms such as *Ophiothrix fragilis* are known to be efficient concentrators of heavy metals including those that are biologically active and toxic (Hutchins *et al.*, 1996). However, there is no information available regarding the effects of this bioaccumulation.

Hydrocarbon contamination High Moderate Moderate Moderate

In a study of the effects of oil exploration and production on benthic communities, Olsgard & Gray (1995) found *Amphiura filiformis* to be very intolerant of oil pollution. During monitoring of sediments in the Ekofisk oilfield Addy *et al.* (1978) suggest that reduced abundance of *Amphiura filiformis* within 2-3 km of the site was related to discharges of oil from the platforms and to physical disturbance of the sediment. Although acute toxicity test showed that drill cuttings containing oil based muds had a very low toxicity (LC_{50} 52,800 ppm total hydrocarbons in test sediment) Newton & McKenzie (1998) suggest these toxicity tests are a poor predictor of chronic response. Chronic sub-lethal effects were detected around the Beryl oil platform in the North Sea where the levels of oil in the sediment were very low (3ppm) and *Amphiura filiformis* was excluded from areas nearer the platform with higher sediment oil content. However, the authors do suggest that effects may also be related to the non-hydrocarbon element of the cuttings such as metals, physical disturbance or organic enrichment. *Amphiura filiformis* is a host for symbiotic sub-cuticular bacteria. After exposure to hydrocarbons loadings of this bacteria were reduced indicating a possible sub-lethal stress to the host (Newton & McKenzie, 1995). However, since field evidence suggests reduced abundance some distance away from oil pollution, intolerance to hydrocarbons is assessed as high. Recovery to original numbers and population structure is likely to take longer than five years (see additional information) and so recovery is assessed as moderate. In addition, oil contamination is likely to remain in the sediment for a long time after the pollution source is removed.

Radionuclide contamination Not relevant

There is insufficient information on the intolerance of *Amphiura filiformis* to radionuclides although adult echinoderms, such as *Ophiothrix fragilis*, are known to be efficient concentrators of radionuclides (Hutchins *et al.*, 1996). There is no information available regarding the effects of such bioaccumulation.

Changes in nutrient levels Tolerant* High Not sensitive* High

Amphiura filiformis responds positively to increased organic enrichment (Nilsson, 1999). In the Skagerrak in the North Sea, a massive increase in abundance and biomass of the species between 1972 and 1988 is attributed to organic enrichment (Josefson, 1990). Rosenberg *et al.* (1997) also reported that *Amphiura filiformis* appeared to be more densely packed in the sediment when food occurred superabundantly compared to when food was less common. Sköld & Gunnarsson (1996) reported enhanced growth and gonad development in response to short-term enrichment of sediment cores containing *Amphiura filiformis* maintained in laboratory mesocosms. Individuals from the more densely populated offshore sediment did not experience enhanced somatic growth (unlike those from the less populated coastal site) indicating a negatively density-dependent relationship. Therefore, it appears that *Amphiura filiformis* can be tolerant* of increases in nutrients. However when increased organic input results in almost complete oxygen depletion, mortality of individuals will occur although this is dealt with in "oxygenation" (see below). For the most part it would appear that *Amphiura filiformis* may benefit from an increase in nutrients and tolerant* has been suggested.

Increase in salinity Not relevant Not relevant Not relevant Not relevant

Amphiura filiformis is a subtidal species generally occurring in areas of full salinity. An increase in salinity would be most unlikely and sensitivity to this factor has not been assessed.

Decrease in salinity High Moderate Moderate Moderate

Amphiura filiformis is a subtidal species generally occurring in areas of full salinity although the species has been recorded from the Sado estuary in Portugal (Monteiro Marques, 1982 cited in Stickle & Diehl, 1987; Table 1) where the salinity is 26psu. However, echinoderms are generally regarded to be stenohaline organisms and a salinity change at the benchmark level is expected to kill individuals of *Amphiura filiformis*. Intolerance is therefore recorded as high. See additional information for recovery.

Changes in oxygenation	Low	Very high	Very Low	High

In experiments exposing benthic invertebrates to decreasing oxygen levels *Amphiura filiformis* only left its protected position in the sediment when oxygen levels fell below 0.85mg/l (Rosenberg *et al*., 1991). This escape response increases predation risk. Mass mortality of *Amphiura filiformis* has been observed during severely low oxygen events (<0.7 mg/l) (Nilsson, 1999). Mass mortality has also been observed following large increases in eutrophication and subsequent reductions in oxygen (Vistisen & Vismann, 1997). Also associated with eutrophic related oxygen depletion is an increase in sulphide concentration in the sediment, which is very toxic to most aerobic organisms. Decreases in sub-cuticular bacteria have also been recorded following nutrient limitation. Reductions in these bacteria are probably indicative of levels of stress and may lead to mortality (Newton & McKenzie, 1995). However, at oxygen concentrations between 0.85mg/l and 1.0mg/l, Rosenberg *et al*. (1991) observed the species was able to survive for several weeks. Therefore, the intolerance of *Amphiura filiformis* to the benchmark oxygen level of 2mg/l for one week is low. There are some effects of decreased oxygenation on the species however. The regeneration rate of arms is significantly decreased at low oxygen concentrations (1.8-2.2 mg/l) (Nilsson, 1999), growth rate is decreased in oxygen concentrations of <2.7 mg/l and spawning is restricted (Nilsson & Sköld, 1996). Therefore at the benchmark level growth rate and regeneration rate are decreased reducing the viability of the population. On return to normal oxygenation levels recovery will be very rapid.

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of microbial pathogens/parasites				Not relevant

No information concerning infestation or disease related mortalities was found.

Introduction of non-native species	Not relevant	Not relevant	Not relevant	Moderate

No non-native species are known to compete with *Amphiura filiformis*.

Extraction of this species	Not relevant	Not relevant	Not relevant	Moderate

It is extremely unlikely that this species would be subject to extraction as it has no commercial and limited research value although dredging operations may remove populations in some habitats.

Extraction of other species	Tolerant	Not relevant	Not sensitive	Moderate

Amphiura filiformis has no known obligate relationships so is not sensitive to the removal of any other species.

Additional information

Recoverability

Breeding is annual and in the UK one period of recruitment occurs in the autumn (Pedrotti, 1993). The larvae of this species can disperse over considerable distances due to their long planktonic existence. Adults, although mobile, are not highly active. Some immigration of adults from nearby populations may be possible. For example, Rosenberg *et al*. (1997) showed that, after a pollution incident where there were no individuals left, 100 adults per m^2 were found after 2 years at several stations. Juveniles were seen 1 year after the incident. However, it can take approximately 5-6 years for *Amphiura filiformis* to grow to maturity so population structure may not return to original levels for at least this length of time. In addition, Muus (1981) showed the mortality of new settling *Amphiura filiformis* to be extremely high with less than 5% contributing to the adult population in any given year. Sköld *et al.*, (2001) also commented on the high mortality and low rates of recruitment. In Galway Bay populations (O'Connor *et al.*, 1983), small individuals make up ca. 5% of the population in any given month, which also suggests the actual level of input into the adult population is extremely low. Therefore, it seems likely that after removal of all or most of the population by a factor, recovery will be determined by the presence of suitable hydrodynamic forces providing new larvae. Once settled the population is likely to take longer than five years to return to maturity and so recoverability from factors to which *Amphiura filiformis* is highly intolerable has been suggested to be moderate.

Importance review

Policy/legislation

- no data -

Status

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

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

Amphiura filiformis provides an important link between the benthic and pelagic environments because it seems to be important in the diets of many fish and invertebrate predators including dab *Limanda limanda* (Duineveld & Noort, 1986) , haddock *Melanogrammus aeglefinus* and Norwegian lobster *Nephrops norvegicus* (Baden *et al.*, 1990). These predators do not generally consume the entire brittle star but crop only the arms, which are later regenerated. An energy budget estimated for the *Amphiura filiformis* population of Galway Bay suggested that arm regeneration contributed significantly to the total annual production of this species (O'Connor *et al.*, 1983).

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