A brittlestar (*Amphiura chiajei*)

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

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A report from:
The Marine Life Information Network, Marine Biological Association of the United Kingdom.

Please note. This MarESA report is a dated version of the online review. Please refer to the website for the most up-to-date version [https://www.marlin.ac.uk/species/detail/1657]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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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	Georgina Budd	**Refereed by**	Dr Mattias Sköld
Authority	Forbes, 1843		
Other common names	-	**Synonyms**	-

Summary

Description

A small brittle star with very long arms which lives buried in muddy sand. Disc may be up to 11 mm in diameter with upper and underside surfaces covered in small smooth scales. Each arm segment has between 4-6 short spines on each side, none flattened or widened at the tip and two large tentacle scales. Colour in life reddish or greyish-brown, often somewhat mottled.

Recorded distribution in Britain and Ireland

Recorded off the west, north and east coasts of the British Isles, mostly below 10 m in depth. There is some doubt over records from the south coast.

Global distribution

Distributed from western Norway (Trondhjemfjord), southwards along European coasts to the Mediterranean, the west coast of North Africa, and the Azores.

Habitat

Amphiura chiajei lives partially buried in mud and muddy sand.

Depth range

10 - > 100 m

Identifying features

- Small disc and long coiled arms, up to 8 times the diameter of the disc.
- Dorsal and ventral surfaces of disc covered with fine scales, those of the dorsal side diminishing gradually in size towards the edge of the disc.
- Primary plates of disc generally distinct.
- Two conspicuous tentacle scales.
- 4-6 conical arm spines.
- Lives buried in mud or fine sand.

Additional information

Other *Amphiura* species are similar. Mixed populations of *Amphiura chiajei* and *Amphiura filiformis* are common.

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	Forbes, 1843	
Recent Synonyms	-	

Biology

Typical abundance	
Male size range	disc diameter < 11mm
Male size at maturity	
Female size range	Small-medium(3-10cm)
Female size at maturity	
Growth form	Stellate
Growth rate	0.5mm/year
Body flexibility	High (greater than 45 degrees)
Mobility	
Characteristic feeding method	Surface deposit feeder
Diet/food source	
Typically feeds on	Organic detritus.
Sociability	
Environmental position	Infaunal
Dependency	No text entered.
Supports	No information
Is the species harmful?	No

Biology information

Feeding method
Amphiura chiajei buries in the sediment with its disc at 4-6 cm depth. One or two arms are stretched up above the sediment to collect food at the surface. Food particles are then transported along the arms to its mouth and ingested (Buchanan, 1964).

Population densities
The species is mostly found in low numbers throughout its range, although a number of high density populations are reported. Survey work by Keegan & Mercer (1986) revealed *Amphiura chiajei* to be a dominant member of the bottom community in Killary Harbour (a fjord-like inlet on the west coast of Ireland). The highly dense population of about 700 individuals per m^2, occurred in sediments with a silt/clay content of 80-90% and organic carbon levels of 5-7%. In contrast, Buchanan (1964) reported the mean population density of *Amphiura chiajei* to be 13 individuals per m^2 off the Northumbrian coast.

Interactions with other species

The heart urchin, *Brissopsis lyrifera*, which typically co-occurs with *Amphiura chiajei*, can negatively affect the growth of body and gonads of *Amphiura chiajei*, whilst *Amphiura chiajei* seemingly has no effect on the growth of *Brissopsis lyrifera*. Hollertz *et al.* (1998) suggested that this was attributable to the extensive bioturbation of the sediment caused by *Brissopsis lyrifera*.

Habitat preferences

Physiographic preferences	Open coast, Offshore seabed, Sea loch / Sea lough, Enclosed coast / Embayment
Biological zone preferences	Bathybenthic (Bathyal), Circalittoral offshore, Lower circalittoral, Upper circalittoral
Substratum / habitat preferences	Mud, Muddy sand
Tidal strength preferences	Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Extremely sheltered, Sheltered, Very sheltered
Salinity preferences	Full (30-40 psu), Variable (18-40 psu)
Depth range	10 - > 100 m
Other preferences	No text entered
Migration Pattern	Non-migratory / resident

Habitat Information

-

Life history

Adult characteristics

Reproductive type	Gonochoristic (dioecious)
Reproductive frequency	Annual episodic
Fecundity (number of eggs)	No information
Generation time	See additional information
Age at maturity	4 years
Season	Summer - Autumn
Life span	5-10 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Planktotrophic
Duration of larval stage	See additional information
Larval dispersal potential	See additional information
Larval settlement period	Insufficient information

Life history information

Lifespan

Munday (1992) suggested from his observations in Killary Harbour, Ireland that individuals of *Amphiura chiajei* attained an age of 10 years, an estimate that was consistent with that reported for populations of *Amphiura chiajei* living off the Northumbrian coast (Buchanan, 1964).

Reproduction

In most species of ophiuroids the sexes are separate and fertilization external, leading to the development of a pelagic larva, the ophiopluteus (Fish & Fish, 1996). Individuals reach reproductive maturity after four years and in *Amphiura chiajei* there is a seasonal cycle in gonad development. A period of rest occurs at the end of autumn followed by growth overwinter. Gonads reach maturity towards the end of spring and summer. Spawning occurs over the period from the end of summer until the middle of autumn (Fenaux, 1970).

Larval settling time and recruitment

In the laboratory, Fenaux (1970) observed a complete larval metamorphosis through to the formation of a young ophiuroid within 8 days at temperature 18-20 °C. Fenaux (1970) suggested that for eggs laid at the end of summer and at the beginning of autumn in which the water temperature exceeds 20°C, the pelagic life is probably shorter. With such a short life in the plankton the dispersal potential is likely to be rather limited in comparison to other echinoderms. *Amphiura chiajei* is a species with sporadic recruitment, which, in combination with its slow growth rate, later maturity and longevity make it a striking contrast to *Amphiura filiformis* (see Buchanan, 1964).

Cohort dominance

A heavy and successful settlement of *Amphiura chiajei* can dominate an area for over 10 years. Buchanan (1964), sampled *Amphiura chiajei* off the Northumbrian coast between 1958 and 1965, and found the entire population to consist of large individuals (disc diameter > 7.5 mm). Between 1958 and 1964, there was no evidence of any new recruitment to the population, but at the end of 1965 a heavy and successful recruitment occurred. Prior to this settlement it was apparent that the same single ageing population had been measured for over 8 years. Spawning had occurred but without successful recruitment. This pattern of longevity and of episodic recruitment is consistent with that if the population of *Amphiura chiajei* in Killary Harbour, west coast of Ireland (Munday & Keegan, 1992). The mortality rate was measured between 1961-1963 and shown to be small.

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	High

Amphiura chiajei is an infaunal species that lives partially buried in sediment with its disc at a depth of 6 cm. It is not sufficiently mobile to avoid substratum removal. Thus removal of the substratum would also remove the resident population of *Amphiura chiajei*and intolerance has been assessed to be high.
In the absence of a resident population, recovery is likely to be achieved through a heavy settlement of juveniles from the plankton which is likely to be more successful in the absence of competition from established adults (Künitzer, 1989; O'Connor *et al.*, 1983), see additional information below.

	Intolerance	Recoverability	Sensitivity	Confidence
Smothering	Low	Immediate	Not sensitive	Low

Amphiura chiajei lives partially buried in sediment with its disc at a depth of 6 cm. As a brittlestar adapted for burrowing it is probably tolerant of additional sediment at the benchmark level and intolerance has been assessed to be low. However smothering by impermeable or viscous materials would probably have an adverse effect upon the brittlestar and intolerance reported to be higher.

	Intolerance	Recoverability	Sensitivity	Confidence
Increase in suspended sediment	Tolerant*	Not relevant	Not sensitive*	High

Amphiura chiajei is a non-selective surface deposit feeder and does not therefore rely on suspended food. However, for most benthic deposit feeders, food is suggested to be a limiting factor for body and gonad growth, at least between events of sedimentation of fresh organic matter (Hargrave, 1980; Tenore, 1988). Consequently, an increase in the suspended matter settling out from the water column to the substratum will be utilisable by *Amphiura chiajei* as a food resource. This suggests that an increase in siltation may be beneficial to the population and the species has been considered to be tolerant*.

	Intolerance	Recoverability	Sensitivity	Confidence
Decrease in suspended sediment	Low	Very high	Very Low	Moderate

Amphiura chiajei is a non-selective surface deposit feeder and therefore does not rely on suspended food. However, for most benthic deposit feeders, food is suggested to be a limiting factor for body and gonad growth, at least between events of sedimentation of fresh organic matter (Hargrave, 1980; Tenore, 1988). *Amphiura chiajei* is likely to be intolerant of a decrease in siltation as a reduced food supply will increase competition and depress growth. Recovery is likely to be rapid once food availability increases.

	Intolerance	Recoverability	Sensitivity	Confidence
Dessication	Intermediate	High	Low	Moderate

Populations of *Amphiura chiajei* occur subtidally and are not likely to be affected by desiccation. However, *Amphiura chiajei* is likely to be intolerant of continuous exposure to air and sunshine for one hour e.g. on the deck of a ship as by-catch. As a mobile, infaunal burrower and crawler it is likely to make efforts to avoid the factor by seeking shade, but the viability of individuals is likely to be affected and some may dry up and die, therefore intolerance has been assessed to be intermediate. Recoverability has been assessed to be high as a proportion of the breeding population is likely to remain.

Increase in emergence regime Not relevant Not relevant Not relevant Low

Emergence is very unlikely to occur in the circalittoral and an assessment of an increase in the emergence regime is not considered relevant for *Amphiura chiajei*.

Decrease in emergence regime Not relevant Not relevant Not relevant Low

Emergence is very unlikely to occur in the circalittoral and an assessment of a decrease in the emergence regime is not considered relevant for *Amphiura chiajei*.

Increase in water flow rate High Moderate Moderate Moderate

Unlike *Amphiura filiformis*, *Amphiura chiajei* shows no clear response to directional bottom currents or an increase in water current rate (Buchanan, 1964). In laboratory conditions, *Amphiura chiajei* maintained a position within the sediment with its arms stretched out across the sediment until 30 cm/s (0.6 knots), when the arms streamed out in the direction of the water current (Buchanan, 1964). If the water current were to increase to moderately strong (1-3 knots), individuals would be unlikely to maintain this position and possibly retract their arms into the burrow, if not loose them. This would prevent the animal from feeding. 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 chiajei* seem to be characteristic of sediments with a silt/clay content of 80-90% and organic carbon levels of 5-7% (Keegan & Mercer,1986), so removal of particular matter is likely to reduce abundance and over a year many individuals may die, so intolerance has been assessed to be high.
With a reduced population, recovery is likely to be achieved through migration and a heavy settlement of juveniles from the plankton, which is likely to be more successful in the absence of competition from established adults (Künitzer, 1989; O'Connor *et al.*, 1983). However, as recruitment tends to be sporadic recovery has been assessed to be moderate.

Decrease in water flow rate Tolerant Not relevant Not sensitive Low

Amphiura chiajei is characteristic of offshore and shallower, stable muddy habitats exposed to only weak or very weak currents. 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 chiajei* has been assessed to tolerate a decrease in water flow rate.

Increase in temperature Low Moderate Low High

The species is distributed in waters to the south of the British Isles and so is probably able to tolerate a long term change in temperature of 2 °C.
Increases in temperature may enhance 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 (unlimited food supply). Juvenile disc diameter increased from 0.5 to 3.0 mm in 28 weeks under these conditions compared to over two years in the North Sea. Mean summer temperatures of 14 °C and an apparent abundant food supply may also account for the early rapid growth of *Amphiura chiajei* in Killary Harbour (Munday & Keegan, 1992). As the species appears to be killed only by extreme increases in temperature, intolerance has been assessed to be low.

Decrease in temperature Intermediate Moderate Moderate High

The species is distributed in waters to the north of the British Isles and so is probably able to tolerate a long term change in temperature of 2 °C.

Populations of *Amphiura chiajei* seem periodically affected by winter cold. Mean densities of *Amphiura chiajei* in Killary Harbour, west coast of Ireland, decreased following months with the lowest recorded bottom temperatures, 4 °C and 6 °C, for February 1986 and January 1987 respectively. Intolerance of the acute change and depressed temperatures on the part of some of the older individuals probably led to their demise (Munday & Keegan, 1992). Low temperatures are also a limiting factor for breeding which occurs in the warmest months in the British Isles. Intolerance has been assessed to be intermediate. Recolonization is likely but assessed to be moderate, see additional information below.

Increase in turbidity Not relevant Not relevant Not relevant Low

*Amphiura chiajei*may be able to perceive changes in irradiance but is probably tolerant of increased turbidity.

Decrease in turbidity Not relevant Not relevant Not relevant Low

Amphiura chiajei may be able to perceive changes in irradiance but is probably tolerant of changes to a decrease in turbidity.

Increase in wave exposure Intermediate Moderate Moderate Moderate

Amphiura chiajei is found offshore and in sheltered coastal habitats characterised by fine muddy sediments and low/negligible wave exposure. Populations of *Amphiura chiajei* occurring offshore at depths greater than 60 m are not subject to exposure from wave action, as the effects are attenuated with depth. However, for populations occurring at depths less than 60 m and nearer the coast, wave action resulting from storms may cause disturbance to the sediment surface and may periodically displace specimens form the sediment (McIntosh, 1875). *Amphiura chiajei* is a burrower and may withdrawal its arms inside the burrow for additional protection, but because wave action may cause displacement and stranding, it is likely to cause some mortality in shallower locations at the benchmark level and intolerance has been assessed to be intermediate.

Decrease in wave exposure Not relevant Not relevant Not relevant Moderate

Amphiura chiajei is found offshore and in shallower, sheltered nearshore habitats characterised by fine muddy sediments and low/negligible wave exposure. Thus an assessment for a decrease in wave exposure was not considered relevant.

Noise Not relevant Not relevant

No information concerning sound or vibration reception in echinoids was found.

Visual Presence Tolerant Not relevant Not sensitive Not relevant

Brittlestars exhibit a wide range of responses to light intensity, from a largely indifferent behaviour to pronounced colour changes and rapid escape behaviour. Aizenberg *et al.* (2001) reported that certain calcite crystals used by brittlestars for skeletal construction are also a component of a specialised photosensory organ. However, these structures are absent in light indifferent species. Thus *Amphiura chiajei* may have visual perception but is likely to have poor visual acuity and consequently probably not sensitive to visual disturbance at the benchmark level.

Abrasion & physical disturbance Low Very high Very Low High

Brittlestars have fragile arms which are likely to be damaged by abrasion or physical disturbance. *Amphiura chiajei* burrows in the sediment and extends its arms across the sediment surface to feed. Ramsay *et al.* (1998) suggested that *Amphiura* species may be less susceptible to beam trawl damage than other species of echinoid 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 brittlestars. Brittlestars can tolerate considerable damage to arms and even the disc without suffering mortality and are capable of disc and arm regeneration. Intolerance to physical disturbance has been assessed to be low. Individuals can still function whilst an arm is regenerating so recovery would probably be rapid.

	Intolerance	Recoverability	Sensitivity	Confidence
Displacement	Low	Immediate	Not sensitive	High

Although not highly active, *Amphiura chiajei* is a crawling, burrowing, infaunal species. Following displacement and return to suitable sediments burrowing amphiuroids start almost immediately to dig downwards (Buchanan, 1964). *Amphiura chiajei* would be exposed to predators for a short time but as fish only tend to take their legs, intolerance has been assessed to be low.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination		Not relevant		Not relevant

Echinoderms tend to very sensitive to various types of marine pollution (Newton & McKenzie, 1995). However, there is insufficient information on the direct intolerance of *Amphiura chiajei* to synthetic chemicals, although it is known to bioaccumulate PCBs (Gunnardsson & Skold, 1999). Loizeau & Menesguen (1993) showed that 8-15% of the PCB burden in dab, *Limanda limanda*, from the Bay of Seine could be explained by ophiuroid consumption. Thus *Amphiura* communities may play an important role in the accumulation, remobilization and transfer of PCBs and other sediment associated contamination to higher trophic levels.
Walsh *et al.* (1986) examined the influence of chronic exposure to tributyltin (TBT) and triphenyltin oxide on arm regeneration in another brittlestar, *Ophioderma brevispina*, and found some evidence of inhibition at 10 ng/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.

	Intolerance	Recoverability	Sensitivity	Confidence
Heavy metal contamination		Not relevant		Not relevant

Information concerning the effects of heavy metals on echinoderms is limited and no details specific to *Amphiura chiajei* were found. However, 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.

	Intolerance	Recoverability	Sensitivity	Confidence
Hydrocarbon contamination	High	Moderate	Moderate	High

Newton & McKenzie (1998) studied the effects of oil-based drill cuttings on burrowing brittlestars, *Amphiura chiajei* and *Amphiura filiformis* and observed responses at both acute and chronic levels. Acute toxicity tests showed that drill cuttings containing oil based muddy drill cuttings had a very low toxicity (LC_{50}= 52,8000 ppm total hydrocarbons in test sediment). A decrease in brittlestar burrowing activity was also recorded at 4,800 and 1,200 ppm total hydrocarbons in sediment. However, Newton & McKenzie (1993) suggested that these were a poor predictor of chronic response. Chronic sub-lethal effects were detected around the Beryl oil platform in the North Sea where the hydrocarbon content of the sediment was very low (<3 ppm total hydrocarbons in sediment), and *Amphiura chiajei* was excluded from areas nearer the platform with higher sediment hydrocarbon content (> 10 ppm). However, the authors did suggest that deleterious effects may also be related to the non-hydrocarbon element of the cuttings such as metals, physical disturbance or organic enrichment.

Amphiura chiajei is also host to symbiotic sub-cuticular bacteria (Kelly & McKenzie, 1995). After exposure to hydrocarbons, loadings of such bacteria were reduced indicating a possible sub-lethal stress to the host (Newton & McKenzie, 1995).
intolerance of *Amphiura chiajei* to hydrocarbon contamination has been assessed to be high, owing to field evidence for exclusion, death and migration by adults and poor colonization by juveniles. Recovery to a pre-impact population structure is likely to take longer than five years (see additional information below) and so recovery has been assessed to be moderate.

Radionuclide contamination Not relevant

There is insufficient information concerning the intolerance of *Amphiura chiajei* to radionuclides, although adult echinoderms, such as *Ophiothrix fragilis* are known to be efficient concentrators of radionuclides (Hutchins *et al*., 1996). No information concerning the effects of such bioaccumulation was found.

Changes in nutrient levels Tolerant Not relevant Not sensitive High

Nilsson (1999) reported a positive response by *Amphiura chiajei* to increased organic enrichment (27 and 55 g C m^{-2}, applied four times over eight weeks) demonstrable by an increase in arm tip regeneration rate. In the Skagerrak in the North Sea, Josefson (1990) reported a massive increase in abundance and biomass of *Amphiura* species between 1972 and 1988 attributable to organic enrichment. Sköld & Gunnarsson (1996) reported enhanced growth and gonad development in response to short-term enrichment of sediment cores containing *Amphiura chiajei* maintained in laboratory mesocosms. Thus increased nutrient availability promoting phytoplankton productivity and an increase in the organic matter reaching the sea bed is likely to be beneficial to *Amphiura chiajei*. For benthic deposit feeders, food is suggested to be a limiting factor for body and gonad growth, at least between events of sedimentation of fresh organic matter (Hargrave, 1980; Tenore, 1988). Nilsson (1999) also found that *Amphiura chiajei* was able to utilise an increased input of organic matter for growth in conjunction with moderate hypoxia. Therefore, it appears that *Amphiura chiajei* is tolerant of an increase in nutrient levels and may indirectly benefit. At the benchmark level *Amphiura chiajei* has been considered to be tolerant.

Increase in salinity Not relevant Not relevant Not relevant Low

Echinoderms are stenohaline owing to the lack of an excretory organ and a poor ability to osmo- and ion-regulate (Stickle & Diehl, 1987). The preferred habitat of *Amphiura chiajei* is found offshore in waters of full salinity where an increase of salinity is not likely to occur.

Decrease in salinity High Moderate Moderate High

Echinoderms are stenohaline owing to the lack of an excretory organ and a poor ability to osmo- and ion-regulate (Stickle & Diehl, 1987). Pagett (1979) examined the tolerance of *Amphiura chiajei* to brackish water (0.5-30 psu) in specimens taken from Loch Etive, Scotland. Loch Etive is a sealoch subject to periods of reduced salinities owing to heavy rain and fresh-water runoff. Pagett (1979) found that specimens nearer freshwater influxes were more tolerant of reduced salinities than those nearer the open sea. *Amphiura chiajei* taken from an area of 24 psu had an LD_{50} of > 21 days for a 70% dilution (17 psu) and an LD_{50} of 8.5 days for a 50% dilution (12 psu). In comparison, specimens taken from an area with salinity 28.9 psu, had an LD_{50} of > 12.5 days for a 70% dilution (20 psu) and an LD_{50} of 6 days for a 50% dilution (14 psu). As *Amphiura chiajei* is mobile and burrows it may be able to avoid changes in salinity outside its preference, e.g. burrowing may help *Amphiura chiajei* to withstand depressed salinities owing to the 'buffering' effect of the substratum. However, as some mortalities were recorded for decreases in salinity over a time period less than the benchmark level, it is likely

that *Amphiura chiajei* would be highly intolerant of a decrease of one category from the MNCR salinity scale for one year.
With a reduced population, recovery is likely to be achieved through migration and a heavy settlement of juveniles from the plankton, which is likely to be more successful in the absence of competition from established adults (Künitzer, 1989; O'Connor et al., 1983). However, as recruitment tends to be sporadic recoverability has been assessed to be moderate.

	Intolerance	Recoverability	Sensitivity	Confidence
Changes in oxygenation	Low	Very high	Very Low	High

In experiments exposing benthic invertebrates to decreasing oxygen levels *Amphiura chiajei* only left its protected position in the sediment when oxygen levels fell below 0.54 mg O_2L^{-1} (Rosenberg *et al.*, 1991). This escape response increases its risk to predators. Mass mortality in a superficially similar species of ophiuroid, *Amphiura filiformis* from the south-east Kattegat has been observed during severe hypoxic events (< 0.7 mg/l), while the abundance of *Amphiura chiajei* remained unchanged at the same site and time (Rosenberg & Loo, 1988).
In laboratory conditions, Nilsson (1999) maintained specimens of *Amphiura chiajei* in hypoxic conditions (1.8-2.2 mg O_2 L^{-1} for eight weeks and recorded no deaths or witnessed specimens escaping to the surface. Rosenberg *et al.* (1991) suggested that *Amphiura chiajei* had a higher tolerance to hypoxia than *Amphiura filiformis* owing to a respiration rate five times lower (0.011 ml O_2 per g wet /wt h^{-1} compared to 0.058 ml O_2 per g wet /wt h^{-1} respectively, at 6°C). This evidence suggests the intolerance of *Amphiura chiajei* to the benchmark level of 2 mg/l for one week to be low.

Biological Pressures

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

No information concerning infestation or disease related mortalities was found.

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of non-native species	Not relevant	Not relevant	Not relevant	Moderate

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

	Intolerance	Recoverability	Sensitivity	Confidence
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 value, although dredging / fishing operations may affect populations in some habitats.

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

Amphiura chiajei has no known obligate relationships so is not directly intolerant of the removal of another species. However, it may constitute a component of demersal fishing trawl by-catch. Whilst some individuals may die, many more may suffer physical injury. Munday (1993) observed that 99% of *Amphiura chiajei* showed evidence of arm tip regeneration in the population off Killary Harbour. Whilst benthic trawling may contribute to arm damage, sub-lethal levels of predation appeared to be the main causative factor for regeneration and was a persistent experience. It is likely that *Amphiura chiajei* would be resistant to damage caused by the extraction of other species and intolerance has been assessed to be low.
Recoverability has been considered to be high owing to the regenerative capability of established adults.

Additional information

Recoverability

Amphiura chiajei is a long lived (> 10 years), slow growing species. As a result an area may become dominated over many years by adults representative of one larval settlement (Munday & Keegan, 1992; Buchanan, 1964). The species has an annual reproductive cycle and is likely to be quite fecund owing to its planktonic development, but juvenile recruitment tends to be very sporadic. In the laboratory, Fenaux (1970) observed completion of larval development within eight days at 18°C. It is not clear whether this is representative of field conditions, but such a short planktonic existence would limit the species powers of dispersal. In addition, the local current regimes of its preferred habitat, e.g. fjordic embayments, would also serve to locally confine planktonic larvae (Pearson, 1970). In long-lived, dense, adult-dominated populations in apparently very stable areas, Künitzer (1989) suggested that the survival of recruits was low owing to competition with established adults, which, as a non-selective surface deposit feeders, may take their own juveniles as a food item at the earliest settlement stage (0.33 mm disc diameter). In contrast, in areas which experience periodic instability, such as the Bay of Concarneau, France, populations of *Amphiura* species are prevented from reaching carrying capacity owing to periodic reduction of the population density (Bourgoin & Goillou, 1988). Likewise, Munday & Keegan (1992) only recorded a successful recruitment of juveniles following the significant demise of adults after depressed winter temperatures in Killary Harbour, Ireland. Therefore, it appears that after removal of all or most of the population by a factor, recovery is possible through larval settlement. However, owing to evidence of a short planktonic existence and the fact that a new settlement will take 4-5 years to reach maturity, recoverability of *Amphiura chiajei* has been assessed 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

-none-

Bibliography

Aizenberg, J., Tkachenko, A., Weiner, S., Addadi, L. & Hendler, G., 2001. Calcitic microlenses as part of the photoreceptor system in brittlestars. *Nature*, **412**, 819-822.

Bergman, M.J.N. & Hup, M., 1992. Direct effects of beam trawling on macro-fauna in a sandy sediment in the southern North Sea. *ICES Journal of Marine Science*, **49**, 5-11.

Bourgoin, A. & Goillou, M., 1988. Démographie d' *Amphiura filiformis* (Echinodermata: Ophiuroidea) en baie de Concarneau (Finistére, France). *Oceanologica Acta*, **11**, 79-87.

Bruce, J.R., Colman, J.S. & Jones, N.S., 1963. *Marine fauna of the Isle of Man.* Liverpool: Liverpool University Press.

Bryan, G.W., 1984. Pollution due to heavy metals and their compounds. In *Marine Ecology: A Comprehensive, Integrated Treatise on Life in the Oceans and Coastal Waters*, vol. 5. *Ocean Management*, part 3, (ed. O. Kinne), pp.1289-1431. New York: John Wiley & Sons.

Buchanan, J.B., 1964. A comparative study of some of the features of the biology of *Amphiura filiformis* and *Amphiura chiajei* (Ophiuroidea) considered in relation to their distribution. *Journal of the Marine Biological Association of the United Kingdom*, **44**, 565-576.

Crompton, T.R., 1997. *Toxicants in the aqueous ecosystem.* New York: John Wiley & Sons.

Crothers, J.H. (ed.), 1966. *Dale Fort Marine Fauna.* London: Field Studies Council.

Fenaux, L., 1970. Maturation of the gonads and seasonal cycle of the planktonic larvae of the ophiuroid *Amphiura chiajei* Forbes. *Biological Bulletin*, **138**, 262-271.

Fish, J.D. & Fish, S., 1996. *A student's guide to the seashore.* Cambridge: Cambridge University Press.

Foster-Smith, J. (ed.), 2000. *The marine fauna and flora of the Cullercoats District. Marine species records for the North East Coast of England.* Sunderland: Penshaw Press, for the Dove Marine Laboratory, University of Newcastle upon Tyne.

Gunnarsson, J.S. & Skold, M., 1999. Accumulation of polychlorinated biphenyls by the infaunal brittle stars *Amphiura filiformis* and *A. chiajei*: effects of eutrophication and selective feeding. *Marine Ecology Progress Series*, **186**, 173-185.

Hargrave, B.T., 1980. Factors affecting the flux of organic matter to sediments in a marine bay. In *Marine Benthic Dynamics* (eds. Tenore, K.R. & Coull, B.C.), 243-263. USA: University of South Carolina Press.

Hayward, P., Nelson-Smith, T. & Shields, C. 1996. *Collins pocket guide. Sea shore of Britain and northern Europe.* London: HarperCollins.

Hayward, P.J. & Ryland, J.S. (ed.) 1995b. *Handbook of the marine fauna of North-West Europe.* Oxford: Oxford University Press.

Hollertz, K., Skold, M. & Rosenberg, R., 1998. Interactions between two deposit feeding echinoderms: the spatangoid *Brissopsis lyrifera* (Forbes) and the ophiuroid *Amphiura chiajei* (Forbes). *Hydrobiologia*, **376**, 287-295.

Hutchins, D.A., Teyssié, J-L., Boisson, F., Fowler, S.W., & Fisher, N.S., 1996. Temperature effects on uptake and retention of contaminant radionuclides and trace metals by the brittle star *Ophiothrix fragilis*. *Marine Environmental Research*, **41**, 363-378.

Josefson, A.B., 1990. Increase in the benthic biomass in the Skagerrak-Kattegat during the 1970s and 1980s - effects of organic enrichment? *Marine Ecology Progress Series*, **66**, 117-130.

Keegan, B.F. & Mercer, J.P., 1986. An oceanographic survey of Killary Harbour on the west coast of Ireland. *Proceedings of the Royal Irish Academy*, **86B**, 1-70.

Kelly, M.S. & McKenzie, J.D., 1995. A survey of the occurrence and morphology of sub-cuticular bacteria in shelf echinoderms from the north-east Atlantic. *Marine Biology*, **123**, 741-756.

Loizeau, V. & Menesguen, A., 1993. A steady-state model of PCB accumulation in a dab, *Limanda limanda*, food web. *Oceanologica Acta*, **16**, 633-640.

McIntosh, W.C., 1975. *The marine invertebrates and fishes of St. Andrews.* Edinburgh.

Mortensen, T.H., 1927. *Handbook of the echinoderms of the British Isles.* London: Humphrey Milford, Oxford University Press.

Munday, B.W. & Keegan, B.F., 1992. Population dynamics of *Amphiura chiajei* (Echinodermata: Ophiuroidea) in Killary Harbour on the west coast of Ireland. *Marine Biology*, **114**, 595-605.

Munday, B.W., 1993. Field survey of the occurrence and significance of regeneration in *Amphiura chiajei* (Echinodermata: Ophiuroidea) from Killary Harbour, west coast of Ireland. *Marine Biology*, **115**, 661-668.

Muus, K., 1981. Density and growth of juvenile *Amphiura filiformis* (Ophiuroidea) in the Oresund. *Ophelia*, **20**, 153-168.

Newton, L.C. & McKenzie, J.D., 1995. Echinoderms and oil pollution: a potential stress assay using bacterial symbionts. *Marine Pollution Bulletin*, **31**, 453-456.

Nilsson, H.C., 1999. Effects of hypoxia and organic enrichment on growth of the brittle star *Amphiura filiformis* (O.F. Müller) and *Amphiura chaijei* Forbes. *Journal of Experimental Marine Biology and Ecology*, **237**, 11-30.

O'Connor, B., Bowmer, T. & Grehan, A., 1983. Long-term assessment of the population dynamics of *Amphiura filiformis* (Echinodermata: Ophiuroidea) in Galway Bay (west coast of Ireland). *Marine Biology*, **75**, 279-286.

Pearson, T.H., 1970. The benthic ecology of Loch Linnhe and Loch Eil, a sea loch system on the west coast of Scotland. 1: The physical environment and distribution of macrobenthic fauna. *Journal of Experimental Marine Biology and Ecology*, **5**, 1-34.

Picton, B.E., 1993. *A field guide to the shallow-water echinoderms of the British Isles.* London: Immel Publishing Ltd.

Ramsay, K., Kaiser, M.J. & Hughes, R.N. 1998. The responses of benthic scavengers to fishing disturbance by towed gears in different habitats. *Journal of Experimental Marine Biology and Ecology*, **224**, 73-89.

Rosenberg, R. & Loo, L., 1988. Marine eutrophication induced oxygen deficiency: effects on soft bottom fauna, western Sweden. *Ophelia*, **29**, 213-225.

Rosenberg, R., Hellman, B. & Johansson, B., 1991. Hypoxic tolerance of marine benthic fauna. *Marine Ecology Progress Series*, **79**, 127-131.

Sköld, M. & Gunnarsson, J.S.G., 1996. Somatic and germinal growth of the infaunal brittle stars *Amphiura filiformis* and *A. chiajei* in response to organic enrichment. *Marine Ecology Progress Series*, **142**, 203-214.

Stickle, W.B. & Diehl, W.J., 1987. Effects of salinity on echinoderms. In *Echinoderm Studies, Vol. 2* (ed. M. Jangoux & J.M. Lawrence), pp. 235-285. A.A. Balkema: Rotterdam.

Tenore, K.R., 1988. Nitrogen in benthic food chains. In *Nitrogen Cycling in Coastal Marine Environments*, (eds. Blackburn, T.H. & Sörensen J.), 191-206. New York: John Wiley & Sons Ltd.

Walsh, G.E., McLaughlin, L.L., Louie, M.K., Deans, C.H. & Lores, E.M., 1986. Inhibition of arm regeneration by *Ophioderma brevispina* (Echinodermata: Ophiuroidea) by tributyltin oxide and triphenyltin oxide. *Ecotoxicology and Environmental Safety*, **12**, 95-100.

Datasets

Centre for Environmental Data and Recording, 2018. Ulster Museum Marine Surveys of Northern Ireland Coastal Waters. Occurrence dataset https://www.nmni.com/CEDaR/CEDaR-Centre-for-Environmental-Data-and-Recording.aspx accessed via NBNAtlas.org on 2018-09-25.

NBN (National Biodiversity Network) Atlas. Available from: https://www.nbnatlas.org.

OBIS (Ocean Biogeographic Information System), 2019. Global map of species distribution using gridded data. Available from: Ocean Biogeographic Information System. www.iobis.org. Accessed: 2019-03-21

South East Wales Biodiversity Records Centre, 2018. SEWBReC Marine and other Aquatic Invertebrates (South East Wales). Occurrence dataset:https://doi.org/10.15468/zxy1n6 accessed via GBIF.org on 2018-10-02.