

LIMPETS (PATELLIDAE) OF THE SOLENT AND ISLE OF WIGHT

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Abstract Limpets (*Patella* spp.) are familiar to all who venture out on to rocky shores. Populations on the Isle of Wight have been a focus of study into their systematics, evolution and as indicators of climate change for nearly a century. Here we briefly review their importance, placing populations in a regional biogeographical context, and present new field survey data for 2024, which we compare with earlier data collected by Crisp & Southward in 1953. Abundance of all larger intertidal species has increased and the warm-adapted species *Patella depressa* and *P. ulyssiponensis* have extended their range eastwards to Bembridge, due to rising sea temperatures. For the first time, *P. depressa* has been recorded on the north shore of the Island. The blue-rayed limpet *Patella pellucida* appears to be generally widespread along the south coast; however kelp, its favoured food and habitat has reduced in recent years, and this is a cause for concern. Nationally, the Isle of Wight is an important monitoring station for seashore fauna and flora due to the existence of long-term population data and its central location in the English Channel, which is of biogeographical significance.

Keywords: Climate Change, English Channel, Marine Ecology, *Patella vulgata*, *Patella depressa*, *Patella ulyssiponensis*, *Patella pellucida*

Introduction

Limpets are amongst the best-known animals inhabiting rocky shores, piers and breakwaters and other hard substrata. Around the Isle of Wight and on the mainland Solent shores, they may be found in all suitable intertidal habitats. Limpets are gastropod molluscs that belong to the Order Patellogastropoda, which is currently split in to three superfamilies of 'true limpets', Eoacmaeoidea, Lottioidea and Patelloidea (Nakano & Ozaawa, 2007). Here we are concerned only with the single family of the Patelloidea, the Patellidae. Within the Patellidae there are four *Patella* species in the British Isles and Ireland, all of which are native to the north-east Atlantic. Three are restricted to intertidal habitats (Fig. 1): the Common limpet *Patella vulgata*, L. is a 'northern' cold-adapted species with a range extending from the Algarve, Portugal northwards to the Arctic Circle in Norway (Bowman & Lewis, 1977); the Black-footed limpet *Patella depressa* Pennant (formerly called *P. intermedia* Murray) is a southern

'warm-adapted' species and occurs on Atlantic shores from the Senegalese coast northwards to Anglesey (Oróstica *et al.* 2021; Southward *et al.* 1995); the China or Rough limpet *Patella ulyssiponensis* Gmelin (formerly called *P. aspera* Roding, a name now reserved for its sister species in the Atlantic Islands which have been shown to be genetically distinct, Weber & Hawkins, 2005) is also a southern warm-adapted species, yet has a broader distribution extending from the Atlantic coast of North Africa and the Mediterranean to southern Norway, although is currently absent in the North Sea south of the Humber (Southward *et al.* 1995). The smaller Blue-rayed limpet, *Patella pellucida* L. is one of the most attractive marine snails and may be seen at low tide on fronds, stipes and holdfasts of kelp, serrated wrack and other weeds, and yet its distribution may also extend sub-tidally to around 30m. The species occurs from Iceland to Portugal, but is absent in the southern North Sea (Hayward & Ryland, 1995).



Fig. 1: Trio of *Patella* spp. on the chalk reef near Mean Low Water at Freshwater Bay, 3rd March 2025.

Above left:
Patella vulgata

Above right:
Patella depressa

Bottom:
Patella ulyssiponensis, typically covered in red algae.



Fig. 2: *Patella depressa* leaving its home scar. Castle Haven 13th November 2024.



Fig. 3: Clumps of *P. vulgata* on the edge of concrete slipway (east side) at Castle Haven. 30th November 2024.



Fig. 4: Clump of *P. vulgata* on south side of concrete groyne at Shanklin, 14th November 2024. Note that grazing activity has removed barnacles by 'bulldozing'.



Fig. 5:

Left: Dog-whelk *Nucella lapillus* predating large *P. vulgata* at Castle Haven 13th November 2024. Note the damp halo surrounding the limpet which is indicative of water loss due to poor foot adhesion, as the animal has succumbed to the dog-whelk's secreted digestive enzymes.

Right: Removal of dog-whelk revealed a drilled hole in the shell.

All *Patella* spp. are important grazing animals and have a tongue-like radula that scrapes either the microbial film and detritus from the rock surface or young algal sporelings and germlings (Hawkins *et al.* 1989; Hill & Hawkins, 1991) as well as larger algae (Jones, 1948; Notman *et al.* 2016). In the case of *P. pellucida*, the younger limpets feed on epiphytes on the fronds or stipes of larger seaweeds as well as the seaweeds themselves, with older individuals migrating into the holdfast on which they feed (Little *et al.* 2009; Hereward *et al.* 2018). The larger seashore limpets have dome-shaped or conical shells that accommodate a powerful muscular foot. This enables these animals to clamp firmly on to rocks to minimise the risk of desiccation and to resist dislodgement by waves and predators such as crabs, birds, rats and fish (Thompson *et al.* 2000; Silva *et al.* 2008).

Over time, adults returning from grazing excursions to precisely the same location create a depression on the rock surface known as a 'home scar' forming a seal (Fig. 2). They are supremely adapted to withstand dislodgement by oncoming waves during storms, and are found on both sheltered and the most wave-exposed coasts (Hawkins & Jones, 1992; Little *et al.* 2009). On rocky shores and other hard substrata, the larger seashore limpets *P. vulgata*, *P. depressa* and *P. ulyssiponensis* are very important ecologically as their grazing activity will often determine the amount of space within an algal canopy into which other species might colonise and occupy. For this reason, although definitions vary, they are often referred to as a 'keystone species' as they are so influential in shaping the diversity and structure of algal and faunal assemblages, particularly on moderately wave-exposed shores (Hawkins, 1981a,b; Hawkins & Hartnoll, 1983; Hawkins & Jones, 1992; Jenkins *et al.* 2005; Coleman *et al.* 2006; Jonsson *et al.* 2006).

Patella species release male and female gametes into the water column, where there is external fertilisation and the development of a planktonic trochophore. Metamorphosis continues with the development of a veliger larva followed by settlement onto hard substrata usually in a pool or damp place. Growth rate is highly variable and dependent on local environmental conditions, including food availability, fucoid cover and species density (Lewis & Bowman, 1975). Where limpet density is greatest, individuals can be smaller due to competition (Boaventura *et al.* 2003; Orostica *et al.*

2020). The largest *P. vulgata* limpets seen on the Island have been in the middle of a canopy of dense knotted wrack *Ascophyllum nodosum* on the vertical sea wall at Bouldnor near Yarmouth (Shell Height 52mm, Shell Length 74mm). Limpets can be solitary or found in groups or 'clumps' (Figs. 3, 4). The cause of these aggregations is unclear, but they may modify the local microclimate to aid water retention at low tide, or resist dislodgement by waves or avian predators, such as oystercatchers (Coleman *et al.* 1999). *Patella vulgata* aggregates under fucoid clumps, whilst *Patella depressa* does not (Moore *et al.* 2011); when clumps were experimentally removed *Patella vulgata* either died, moved to another *Fucus* clump or aggregated with other limpets on open rock.

Individuals may be eaten by crabs and fish; dogwhelks (*Nucella lapillus*) will drill into their shells with their radula, secrete a digestive enzyme and insert their feeding proboscis (Fig. 5). Numerous limpet shells (mostly *P. vulgata*) have been found in Neolithic and Bronze Age middens on the Isle of Wight and elsewhere, suggesting that the animals were harvested and been common in the diet of early coastal human populations (Preece, 1986, 1993; Thomas & Maninno, 1998).

The vertical distribution of the three species around the Isle of Wight differs. *P. vulgata* is found between Mean High Water Springs and Mean Low Water Springs; *P. depressa* occurs from about Mean Neap level to Mean Low Water Neaps. The China limpet *P. ulyssiponensis* is generally found lower on the shore from Mean Low Water Neap Tide mark to Low Water Spring Tide level, as well as in mid-shore rock-pools. All are found on exposed and moderately exposed coasts, but only *P. vulgata* extends on to very sheltered shores and the wharves and pilings at the mouth of estuaries and in harbours.

This review will mainly focus on the larger 'seashore' species of *Patella* spp. around the Isle of Wight and update local distribution following survey work in the autumn of 2024. For completeness, a brief update on the status of *P. pellucida* is also included. Results are placed in the context of the regional biogeography on the south coast of England and around the British Isles.

History and Biogeography

In *A Guide to the Natural History of the Isle of Wight* (Morey, 1909) only *P. vulgata* and *P. pellucida* (as *Helcion pellucida*) are noted, when they both appear to have been widespread. Sea temperature in the early years of the 20th Century was generally cold, so it would not be surprising if the other warm-temperate *Patella* spp. were absent or rare during this period. However, limpet taxonomy was in a considerable state of flux in the early 1900s with what became recognized as different species being considered as varieties of *P. vulgata*. Other limpet species remained unrecorded on the Island until the French biologist Edouard Fischer-Piette sampled common animals and seaweeds at St Catherine's Point (Watershoot Bay) in September 1932, and at Culver Cliff and Freshwater Bay in March 1934 (Fischer-Piette, 1936). These sites were included in a regional study of common intertidal

animals on both sides of the Channel that established evidence for a biogeographic boundary roughly between the Isle of Wight and the Continent Peninsula. During this work he observed 'intermediate' forms of *P. vulgata* and *P. depressa*, that he referred to as *Patella intermedia*. However, he later accepted that he had mistakenly named *P. depressa* as *P. aspera* (now known as *P. ulyssiponensis*), (Fischer-Piette, 1938 p268, 1941 p3), so the early records are confusing and there are no useful measures of abundance. However, in the 1930s and 1940s he continued to be interested in the 'intermediate' or 'transitional' populations of *Patella* spp. from the Island, even claiming that some individuals had 'facies' of the Mediterranean species *Patella caerulea*.

Referring to the work of Fischer-Piette, Julian Huxley, evolutionary biologist, conservationist and grandson of T. H. Huxley, suggested that it was impossible to say whether the divergence of *Patella* on parts of the south-coast represented either a primary step towards complete species separation or was secondary resulting from the hybridisation of three previously differentiated types (Huxley, 1942). In either case it is difficult to imagine how speciation might occur as the region is not geographically or ecologically isolated. In the late 1940s, the biologist Ronald Evans followed up these earlier observations and also found intermediate types of shell lining and pluricuspid teeth on the radula as one worked east in the Channel towards the Isle of Wight (Evans, 1953).

Both Fischer-Piette and Evans regarded populations in the vicinity of the Isle of Wight as areas of emergence of species from a more primitive ancestral stock, yet the possibility of hybridisation could not be overlooked (Fretter & Graham, 1962 p496-498).

In laboratory experiments at Southampton University, PhD student Deborah Hatch found some evidence for species hybridisation (Hatch, 1977). However, using immunological methods and electrophoresis it was impossible to distinguish between the blood sera of *P. vulgata* from that of 'transitional forms'. It was therefore concluded that the 'transitional forms' were variable *P. vulgata* and that hybridisation in the region was minimal. Yet in a comparison of mainly internal shell characteristics of populations at Freshwater Bay and Alum Bay, with Swanage and Portland Bill, she estimated that misidentification of *P. vulgata* and *P. depressa* and *vice versa* was higher at the Isle of Wight localities; at Freshwater Bay this was 6-15%. (n=200 specimens). Subsequent molecular investigations in the Channel and elsewhere have found no evidence for hybridisation of *Patella* spp. (Gaffney, 1980; Sá-Pinto *et al.* 2005).

A more thorough investigation of Channel intertidal biogeography was carried out by Alan Southward (Plymouth Laboratory) and Dennis Crisp (Menai Bridge Marine Biology Station) who sampled shores on the Isle of Wight in July 1953 (Crisp & Southward, 1958). They too established evidence for a discontinuity in the mid-Channel between northern 'Boreal' cold adapted species in the east and warm-adapted 'Lusitanian' species in the west.

At that time, *P. vulgata* was ubiquitous on intertidal hard substrata along both sides of the Channel, yet on the English coast, *P. depressa* and *P. ulyssiponensis* did not extend eastwards of the Isle of Wight or in the southern North Sea, confirming observations of Fischer-Piette (1936) and Evans (1953). On the French coast, a similar discontinuity occurred on the Contentin Peninsula, with eastern limits of both species around or near Barfleur.

The next flurry of activity centred around the effect of the exceptionally severe winter 1962-63 on marine life around the British Isles, including the Channel. Alan Southward had visited shores on the Island in May 1960 and again reported in his notebooks on the abundance of common species as he had done in 1953. Compared to the early years of the decade, sea temperatures in the mid-late 1950s had been relatively warm. He found *P. vulgata* to be 'Abundant' at all sites and recorded the proportion of *P. depressa* in the mid-tidal region at St. Catherine's Point and Woody Bay as 6% of all limpets, and 8% on the shore east of Ventnor. He reported *P. ulyssiponensis* to be between 1-6% of limpets at low water at shores along the Undercliff and 10% at Bembridge. However, in the spring following the icy winter, although *P. vulgata* was widely present, both *P. depressa* and *P. ulyssiponensis* were absent and/or not found (Alan Southward notebooks; Crisp, 1964). Writing in these *Proceedings* for 1967, local conchologist Leslie Prebble observed, '*the large flat limpet Patella depressa, which before 1963 could be found in reasonable numbers at Hanover Point, Brook, and the eastern side of Ventnor, now seem to have completely vanished* (Prebble, 1968). Almost certainly Prebble was referring to *P. ulyssiponensis*, as *P. depressa* is not a 'large' limpet and has been incorrectly labelled in his shell reference collection (Killeen, 1994). However, *P. depressa* was used as a synonym of what was then *P. aspera* and now considered *P. ulyssiponensis* up to the 1930s.

Between 1963 and 1975, Alan Southward made a further four visits to the Island to monitor the recovery of populations of limpets and other intertidal species, by which time mean annual temperatures were falling as the North-Atlantic entered another cool phase. Yet by the late 1960s and early 1970s there had been a recovery of both species at most of their former sites, with *P. ulyssiponensis* and *P. depressa* reported as 'Common' at Freshwater Bay. One of us (S.J.H) continued the time series with occasional visits to the Island from the 1980s (Kendall et al. 2004) to the present, joined by others (including R.J.H.H) in the 1990s as part of the Maine Biodiversity and Climate Change (MarClim) project based at the Marine Biological Association in Plymouth (Mieszkowska et al. 2005).

The geographical limits of warm-temperate species set in the mid-Channel around the Isle of Wight, remained broadly similar until the 2000s, when increases in abundance and range shifts were first observed.

Methods

Monitoring effort of populations of seashore organisms around the British Isles has increased,



Fig. 6: 'Limpet ledge' on the chalk reefs of Freshwater Bay, viewing east along the south-west coast of the Isle of Wight to St. Catherine's Point.

largely as a result of the MarClim project. Following the same general protocol followed by Crisp & Southward (1958), surveys are carried out for a suite of intertidal 'climate indicators' - mostly species that are 'northern' and 'southern' in European distribution, but also some 'intermediate' and non-native taxa. One of us (S.J.H) overlapped with Dennis Crisp and Alan Southward and was able to undertake cross-calibration of field methods on the shore for consistency and to maintain accuracy of the time-series, and co-workers have also followed this protocol.

Survey Sites

For comparative purposes, survey sites follow those sampled by Crisp & Southward (1958) and subsequently by Alan Southward and others. The majority of sites are on the south coast of the Island where there is a variety of rocky intertidal habitat. There are wave-exposed chalk platforms and boulders at Freshwater Bay (Fig. 6), sandstone boulders along the Undercliff between Watershoot Bay and Ventnor and moderately exposed flat limestone reefs at Bembridge and Colwell. The exact location of Crisp and Southwards sites at St. Catherine's Point and Blackgang is questionable. It is known that they camped at Castle Haven (A. J. Southward personal communication), near the existing caravan park, so it is likely that they went on the shore below the cliff or eastwards in to Reeth



Fig. 7: Prof. Steve Hawkins sampling *Patella* spp. on the east side of Watershoot Bay in October 2024.

Bay, which is mentioned in his notebook for 1960. Fischer-Piette (1936, p189) surveyed the eastern end of Watershoot Bay and it is possible that this site is what is referred to as 'Blackgang' by Crisp and Southward, as the shore further to the west beyond Rocken End is difficult to access and consists mostly of shingle and pea gravel. Piers at Ryde,

Sandown and Shanklin were sampled by Crisp and Southward (1958), but Shanklin Pier collapsed in the Great Storm of October 1987, so the large concrete

Table 1. Limpet Abundance scale from Crisp & Southward (1958) and used in this study.

Abundant (A)	Over 50 per m ² or more than 50% of limpets at certain levels
Common (C)	10-50 per m ² , 10-50% of limpets at certain levels
Frequent (F)	1-10 per m ² , 1-10% of limpets at certain levels
Occasional (O)	Less than 1 per m ² on average, less than 1% of limpets
Rare (R)	Only one or two found in 30 min searching
Not Seen (N)	Not seen in 30 min searching

groynes immediately east of this location and the sandstone shore at Horse Ledge were also examined. The ledges at Bembridge are extensive and limpet density is very variable, yet the highest densities are found on the reef edges where there are grazing enclaves and a narrow limpet-barnacle zone. Previously, higher densities of *P. ulyssiponensis* have been found on the outer ledges, than further inshore at Lane End, which Crisp and Southward refer to, so data from both areas was collected.

Field survey

There is no published information on sample or quadrat size attached to the earlier surveys from 1950s-1970s, but Southward generally used 0.5 x 0.5 m quadrats (S.J.H worked with him in the field).

Following the new MarClim protocol, ten 50 cm x 50 cm gridded quadrats (Fig. 7) were placed at around Mean Tide Level (MTL) avoiding areas with greater than 5% fucoid cover, for *P. vulgata* and *P. depressa*, or wherever *P. depressa* is most abundant. On some shores this can vary between High Water Neap Tide level (HWNT) and Low Water Neap Tide level (LWNT). Additional data collected included rock aspect, angle, barnacle cover and fucoid (large brown algae) cover. The larger *P. ulyssiponensis* is normally found below LWNT mark, and often in rock pools with coralline algae such as *Lithothamnion* spp. Abundance was measured by placement of quadrats or by field classification using the Abundance Scale (Table 1).

Species identification

As previously discussed, the shell morphology of *Patella* species is notoriously variable. With experience, reliable and consistent identification is possible from external characteristics, however it is sometimes necessary to lift a shell to check the colour of the foot and the pallial tentacles (Figs. 8, 9, 10). This is particularly the case in separating some *P. vulgata* and *P. depressa*; several specimens of *P. vulgata* from the sea wall at Cowes Parade that had external characteristics very similar to *P. depressa*, had us both fooled! However, from our experience we consider that for each species, misidentification based on external shell characteristics is about the

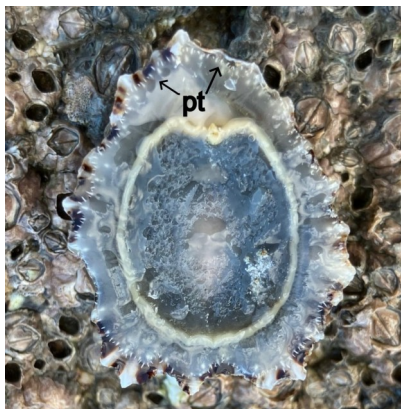


Fig. 8: *Patella depressa*. **Above** Ventral view, showing characteristic black foot and chalky-white pallial tentacles (pt). Concrete groyne at Shanklin 14th November 2024. Mouth at top of photo. **Below:** pale-footed specimen on stone support at Ryde Pier 12th November 2024.

Fig. 9: *Patella ulyssiponensis*, **Above:** Ventral view, showing bright orange foot and white-cream pallial tentacles. Mouth at top of photo. Freshwater Bay 28th February 2025. **Below:** Juvenile and adult *P. ulyssiponensis* grazing in a coralline pool at Watershoot Bay, 17th October 2024.

Fig.10: *Patella vulgata* **Above:** Ventral view with yellow-green foot. Mouth at top of photo. Bembridge, 20th February 2025. **Below:** Green algae on the shell tops of *P. vulgata*, where it cannot readily be grazed off! Grantham Rocks, Cowes, 21st August 2024.

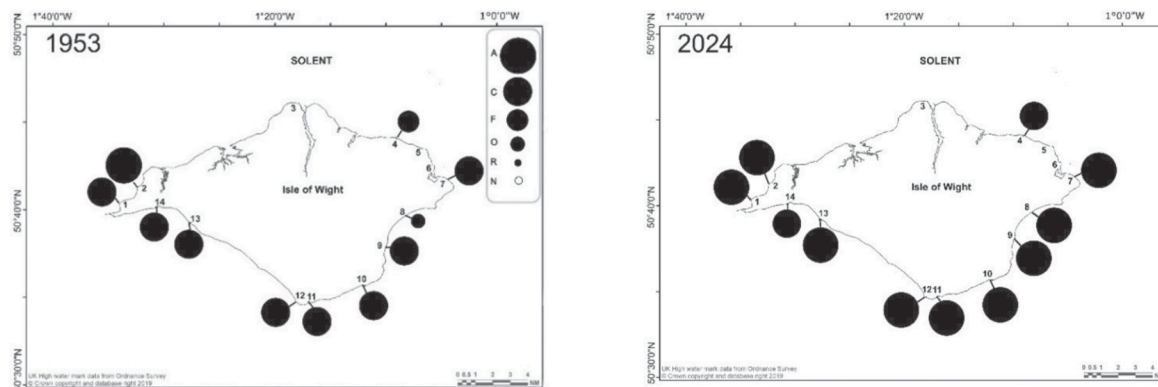


Fig. 11: Distribution of *P. vulgata* in 1953 (Crisp & Southward, 1958) and in 2024. See left map and Table 1 for Abundance scale.

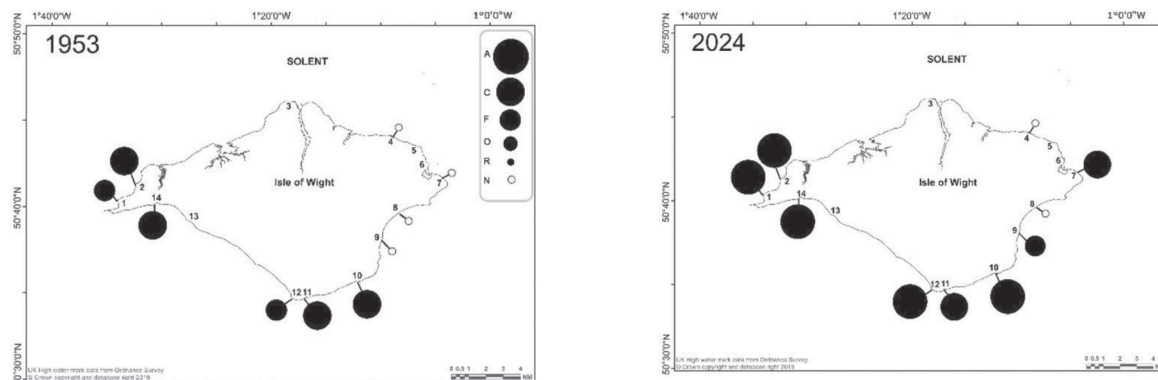


Fig. 12: Distribution of *P. ulysiponensis* in 1953 (Crisp & Southward, 1958) and in 2024. See left map and Table 1 for Abundance scale.

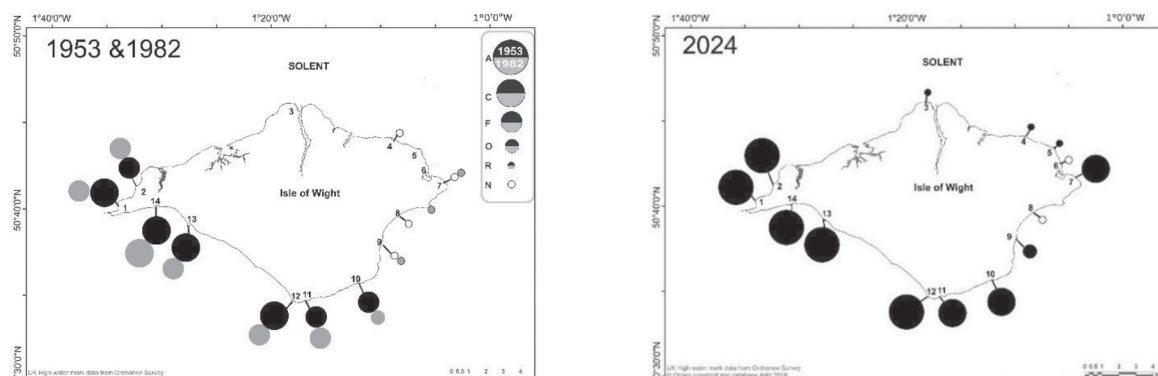


Fig.13: Left: Distribution of *P. depressa* in 1953 (black circles) (Crisp & Southward, 1958), 1982 (grey circles) (data from map in Kendall *et al.* 2004). **Right:** Distribution in 2024; see left map and Table 1 for Abundance scale.

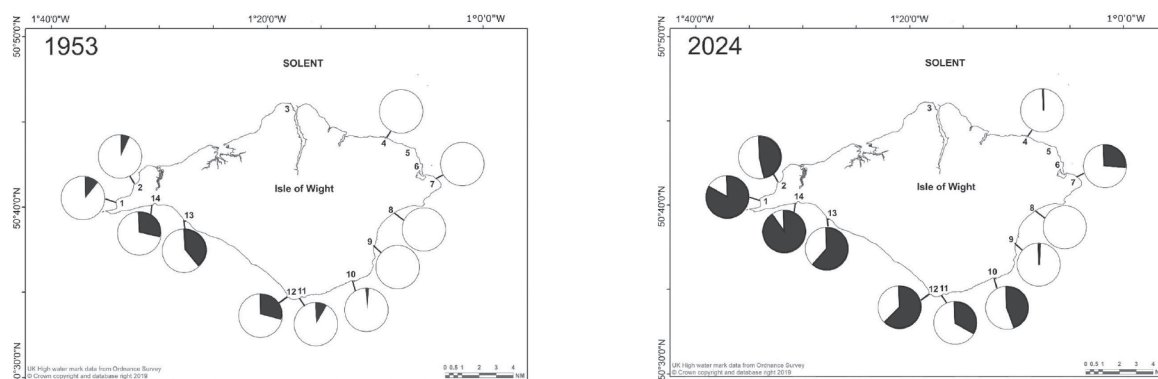


Fig. 14: Proportion of *P. depressa* (black segments) of total limpet population (the rest were *P. vulgata*) where the species was most abundant, normally between Mean Tide Level and Low Water Neap Tide level. Data for 1953 from Crisp & Southward (1958).

Survey sites for each map are 1: Alum Bay (Hatherwood Pt.); 2: Colwell Bay (Warden Ledge); 3: Cowes Parade and Royal Yacht Squadron; 4: Ryde Pier; 5: Seaview; 6: St Helens Ledge; 7: Bembridge; 8: Sandown Pier; 9: Shanklin; 10. Ventnor; 11. Castle Haven; 12. Watershoot Bay; 13. Brook (Hanover Pt.), 14. Freshwater Bay (W.)

Table 2. Summary of abundance from surveys in 2024. Mean density and Standard Deviation (SD) calculated from counts (all limpet sizes) in 0.5 m x 0.5 m quadrats. See Table 1 for Abundance Scale category given for *P. ulyssiponensis*. The % column refers to percentage of *P. vulgata* and *P. depressa* in the mid-shore community.

Shore type and substrata categories based on Crisp & Southward (C&S) (1958). Key: R, rocks other than chalk; C, chalk; B, Boulders (over 10 cm diameter); G, Gravel 10 cm to 2 mm diameter); S, sand (2mm-0.02mm diameter); P, piers, groynes and sea walls and other structures; F, Flat rocks (limestone and sandstone reefs); I, broken surfaces, all angles.

Sites	Position	Shore Type	Date	No. Quadrats	<i>Patella vulgata</i>		<i>Patella depressa</i>		<i>P. ulyssiponensis</i>
					Mean per m ² (SD)	%	Mean per m ² (SD)	%	
Colwell Bay (Warden Ledge)	50.68892° N; 1.54147°W	R, I, B	15.11.24	10	110.4 (45.5)	52	100 (38.8)	47	C
Alum Bay (Hatherwood Pt.)	50.67221° N; 1.57007°W	R, I, S	02.11.24	10	64.8 (21.6)	16	344 (169.4)	84	A
Freshwater Bay (West)	50.66843° N; 1.51317°W	C, I, B	18.10.24	10	22.0 (10.4)	9	226.4 (51.2)	91	A
Brook (Hanover Pt.)	50.65160° N; 1.46469°W	R, F, S	18.10.24	10	96.4 (26.8)	38	158.0 (42.9)	62	A
Watershoot Bay (East)	50.57607° N; 1.30432°W	R, I, G	17.10.24	10	87.6 (27.9)	36	150.8 (26.5)	63	A
Castle Haven	50.57702° N; 1.28684°W	R, B	30.11.24	10	64 (30.3)	34	32.8 (16.0)	63	C
Ventnor (La Falaise)	50.59187° N; 1.21190°W	R, B	15.10.24	10	56.4 (17.8)	56	45.2 (12.2)	44	A
Shanklin groyne	50.62976° N; 1.17083°W	P, S	14.11.24	10	111.6 (33.3)	99	<1	0.4	F
Shanklin Horse Ledge	50.61867° N; 1.17196°W	R, F, I, B	14.11.24	10	152.0 (42.0)	98	2.8 (2.7)	2	F
Sandown Pier	50.65250° N; 1.15492°W	P, S	12.11.24	10	74.4 (18.2)	100	0	0	N
Bembridge, Outer Ledges	50.68460° N; 1.06464°W	R, F, S, P	16.01.24	10	26.4 (10.7)	73	10 (5.1)	27	C
Bembridge, Lane End	50.68716° N; 1.06849°W	R, F	20.02.25	10	79.6 (5.8)	100	0	0	C
St. Helens	50.70208° N; 1.09819°W	R, F, S	12.12.24	10	92.8 (26.0)	99	<1	<0.5	N
Seaview	50.72082° N; 1.10872°W	R, F, S	01.11.24	10	104.8 (38.1)	98	2 (2.8)	2	N
Ryde Pier	50.73390° N; 1.16032°W	P, S	12.11.24	10	44.8 (21.1)	99	0.4 (1.3)	1	N
Cowes (West)	50.76646° N; 1.30057°W	P, B	18.10.24	5	157.6 (17.3)	1	2.4 (5.4)	99	N

same, so it is cancelled out. For species diagrams, photographs and further information refer to Hawkins & Jones (1992) and Smith (2020 ab, 2024). We have found that the most important and reliable indicator is the colour of the pallial tentacles visible around the perimeter of the mantle (Fig. 8). Larger *P. ulyssiponensis* may be well camouflaged with red algae, and this can be a useful aid to their location and identification (Fig.1).



Fig. 15: *Patella depressa* group on sandstone boulder at Watershoot Bay 17th October 2024. Note irregular outline of shell base, anterior shell apex and 'strong' rays/ribs leading from apex posteriorly, resembling 'fish-tail'. Older, worn specimen to the right.

Survey results

All three larger *Patella* spp. still occur at their former sampling sites, and have become more abundant since 1953 (Figs. 11-13). The range of warm adapted species has expanded in the east of the Island and *P. depressa* has been recorded on the Solent coast of the Island for the first time. Where species were Common or Abundant, multiple age cohorts could usually be identified and there was evidence of recruitment, often in moist areas and in shallow pools. A data summary is presented in Table 2.

Highest densities of *Patella* spp. were on the wave exposed southern and western shores, with over 400 per m² (all age cohorts) recorded on some boulders at Hatherwood Point in Alum Bay. Limpets were mostly absent from softer clay and marls, yet minor depressions in the soft chalk at Freshwater Bay and

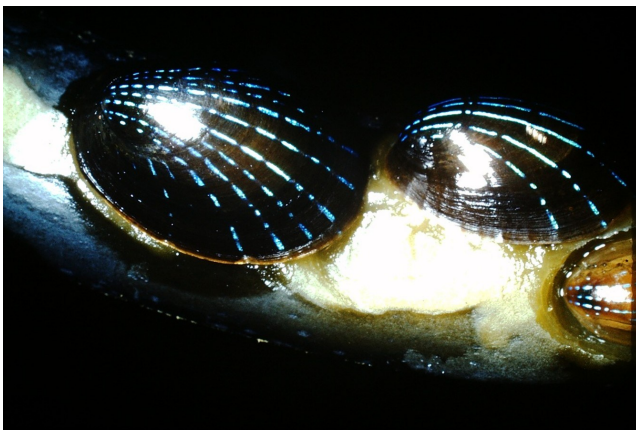


Fig. 16: Blue-rayed limpet *Patella pellucida* grazing on stipe of kelp *Laminaria digitata* at Freshwater Bay, April 1980.

on limestone may create more optimal microhabitats for recruitment and feeding. Here and on the exposed Undercliff shores, where low tide conditions during the daytime are more humid, it is not uncommon to see limpets with shells raised high grazing quite freely – and noisily! The proportion of *P. depressa* in the mid shore region has increased markedly since 1953 (Fig. 14) and the species has become the dominant limpet on shores in the west of the Island (Fig. 15).

Coastal infrastructure, including concrete groynes and seawalls and limestone and granite rock armour has provided new habitat for both *P. vulgata* and *P. depressa*.

Patella pellucida

In the 1980s, the distribution of the blue-rayed limpet *P. pellucida* (Fig. 16) was generally widespread along the south coast of the Isle of Wight (Fig. 17). Recent records on the National Biodiversity Network map indicate that the species is still present in many localities in the south of the Island, and there have been some observations on the Solent coast too. Yet, population size is of concern as kelp (*Laminaria* spp.), has suffered significant losses in recent storms. Although the species can be found sub-tidally, most local records are intertidal or very close inshore, which may indicate that kelp is more sparsely distributed offshore. The ecotype *P. pellucida* var. *laevis*, which is pale coloured and confined to the base and interior of kelp holdfasts has not been recorded in recent years, yet can be searched for within the holdfasts of freshly washed-up kelp.

Discussion

We do not present a full time-series for Isle of Wight shores, so need to interpret the data with caution, and sampling methods have changed since the 1950s. On the English side of the Channel, the eastern geographical limits of *P. depressa* and *P. ulyssiponensis* occurred on the Isle of Wight until about 2000. Local populations have now increased and there is a range expansion eastwards along the mainland coast of England: *P. depressa* has been recorded at Beachy Head (in the 2010s) and Hastings (2020s) and *P. ulyssiponensis* at Dover in 2018 (Herbert, et al. 2022). The increase in local populations and range expansion of both these

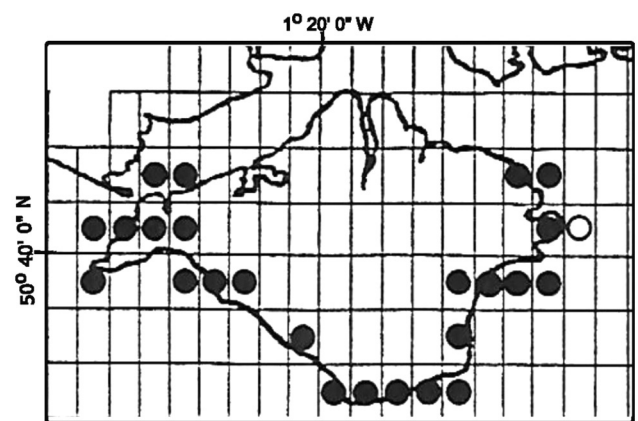


Fig. 17: Distribution of *Patella pellucida* adapted from Light (1990). Black dots indicate 'live animals'; open circle a 'worn shell'. The most recent NBN map (14.02.24) is similar with new records on the Solent coast.

species can be explained by climate warming, as reproductive period and fecundity increases with higher air and sea temperatures (Southward *et al.* 1995; Hawkins *et al.* 2008, 2009; Moore *et al.* 2011). Around the UK, sea surface temperature (SST) shows a significant warming trend of around 0.3°C per decade over the last 40 years (Cornes *et al.* 2023). Higher gamete output from a prolonged reproductively active season (Moore *et al.* 2011) from Isle of Wight populations will have increased the probability of larval dispersal eastwards towards the Sussex and Kent coast, overcoming hydrographic barriers including complex tidal currents and the gyre off Bembridge (Keith *et al.* 2011). In the early 1980s towards the end of the cool period from 1962/63 onwards, *P. depressa* was rarer at some south-western shores compared to the 1950s (Fig 13). However, odd individuals of *P. depressa* and *P. ulyssiponensis* were found by S.J.H at Culver Cliff and Bembridge (on the outer reefs), not previously recorded by Crisp and Southward. Yet, by the mid-1980s, the proportion of *P. depressa* amongst mid-shore limpets was on the rise, as at other locations in south-west Britain (Southward *et al.* 1995 Fig. 17).

Larval settlement will have been enabled by increased habitat due to the construction of hard sea defences such as rock groynes, breakwaters (e.g. Monks Bay, Bonchurch; Cowes Breakwater; Elmer 'offshore islands' between Bognor and Littlehampton). These structures may have acted as 'stepping stones' and facilitated eastward expansion along the coast where there is soft-sediment substrate. Milder winters will have enhanced juvenile and adult survival of *P. depressa* as we know the species suffered high mortality during the cold winter of 1962-63 (Crisp, 1964; Prebble, 1968). The new limestone boulders placed at the foot of the cliff at Ventnor and Reeth Bay have created new habitat and the vertical range of *P. vulgata* has been extended. We do not present any data from the mainland shores of the Solent, however there are no natural rocky platforms and the only hard substrata are coastal infrastructures. Yet we do know that *P. vulgata* occurs on these structures and *P. depressa* has been found at Hayling Island (Hawkins *et al.* 2009) and Lee on Solent (S.J.H unpublished observations).

Interestingly, populations of *P. vulgata* also appear to have increased at most sites since 1953. Severe storms can remove large quantities of seaweed from exposed shores and this may have created more space for limpets to recruit, grow, and occupy. In the 1990s, dense fucoids, including knotted wrack *Ascophyllum nodosum*, occupied a wide zone on the shore just east of Castle Haven slipway, yet this has now disappeared, probably as a result of storms, combined with impacts of coastal defence works, and been replaced by grazing limpets. Over the past 30 years, a large patch of limpets has appeared within the canopy of *Fucus serratus* on the limestone reefs at Bembridge, just south of the lifeboat station. This could be as a result of natural cyclical patch dynamics (Hawkins & Jones, 1992), extreme summer heat that has trimmed back the brown fucoid algae

and opened up the canopy, a higher storm frequency that has also removed algae, or reduced barnacle settlement which can impede limpet grazing.

The relationship between climate and species populations on rocky shores has only been established thanks to the maintenance of long-term times series on the Isle of Wight and elsewhere around the British Isles. The longevity and quality of the data base has influenced not just scientific curiosity and understanding, but also climate and coastal policy makers at a national and global scale (Hawkins *et al.* 2016). It is our hope that a new generation of marine ecologists and naturalists will continue to contribute and gain new insights in to the distribution of *Patella* and their biology and ecology in the years to come.

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