

THE RECOVERY OF *CHTHAMALUS STELLATUS* FROM THE EFFECTS OF THE SEVERE WINTER OF 1962-63 ON THE SHORES AT PORNIC, FRANCE.

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Résumé

Des observations poursuivies sur les rivages de Pornic (Bretagne) pendant plusieurs années, permettent de mettre en évidence les variations des populations de *Chthamalus stellatus* dues aux effets profonds de l'hiver rigoureux de 1962-1963. Au cours de l'été 1965, le renouvellement était à peu près complet.

The extremely severe winter of 1962-63, affecting much of western Europe, had a marked influence on a wide variety of marine animals. As would have been expected, the effects were most strikingly obvious on southern forms living near their northern limits and with such species the whole population was virtually decimated in some localities. In most cases it was assumed—and quite rightly—that the observed mortality and population changes both in the littoral zone and inshore waters were due to the low winter temperatures. As a result of a survey of western European coasts during the summer of 1963 a direct correlation between winter temperature anomalies and the mortality of two common intertidal cirripedes, *Chthamalus stellatus* and *Balanus perforatus* (the one high and the other low intertidal) has been demonstrated by Barnes and Barnes (1966, q.v. for further references).

During this survey the situation at Pornic just south of the Loire estuary was twice investigated in some detail. At Pornic the boreo-arctic *Balanus balanoides*, although relatively more abundant than in some places on this coast, is nearing its southern limit on the French Atlantic coast (Barnes and Powell, 1966) although a more southerly outlying population exists in northwestern Spain. This shore had been seen in the spring of 1962, that is, before the severe winter and was again examined in the summers 1963 and 1965. The recovery observed in 1965 seems worth recording.

In the early summer of 1963, following the severe 1962-63 winter much of the *Chthamalus stellatus* over the whole shore was dead; at the upper levels mortality was 100 % and lower down 80-90 %. The spring (1963) spat-fall of *Balanus balanoides* had been very heavy over much of the littoral and everywhere crowding had resulted in loss of the population with the production of bare areas (Barnes and Powell, 1950). By the early autumn of the same year much of the

dead adult *Chthamalus* had broken away, again exposing bare rock which was being re-colonized by *Chthamalus* spat (density, 5-10/cm² according to the level). *Elminius modestus* spat was also present in such places. At this time, however, the situation had by no means been restored to its "normal" appearance—that seen a few years earlier.

By the summer of 1965 the upper shore had completely recovered from the decimating effect of the 1962-63 winter; adult *Chthamalus* (settled in 1963-64) formed a complete cover which, because of crowding, was in places breaking away. Only a very occasional dead *Chthamalus* was found. *Chthamalus* (40/cm², contrast 10/cm² above) and some *Elminius* spat was present on such bared areas. At this level *B. balanoides* was restricted to tide pools, where it was abundant, or to sheltered overhanging rocks. *Chthamalus* extended into the splash zone, both as adults and newly settled cyprids and young spat. At the lower levels *Balanus balanoides* was still common mixed with *Chthamalus* and some *Elminius*; spat of *Chthamalus* was abundant wherever the rock was bared.

It is evident that within two years the dominance of *Chthamalus* over the mid and upper littoral had been completely re-established. It would appear that at Pornic *Chthamalus stellatus* and *Balanus balanoides*, as regards their competition for intertidal space, are in a "precariously" balanced steady state and that whilst only a severe winter such as that experienced in 1962-63 will produce the striking and obvious changes described above, smaller changes in the annual temperature regime will regularly affect their inter-specific competition and relative population densities. Warmer winters will favour *Chthamalus stellatus* while *Balanus balanoides* will benefit from colder winters and, of course, cooler summers. This is in accordance with their geographical distribution; *Chthamalus stellatus* is a warm water species, abundant on the western European coasts and extending southwards to northwest Africa, but only being found on the west and north coasts of Britain. *Balanus balanoides* is largely boreo-arctic in its distribution. The results are also a striking confirmation of the fact that the down-shore spread of *Chthamalus stellatus* is markedly under the influence of *Balanus balanoides* so that as one proceeds northwards and conditions become more favourable for the latter species, the former is more and more restricted to the upper levels of the shore.

Summary

Observations of the shore at Pornic over a period of several years allows an account to be given of the changes in the population of *Chthamalus stellatus* arising from the marked effects of the severe winter of 1962-63. By the summer of 1965 recovery was virtually complete.

Zusammenfassung

Die Untersuchungen, die während mehrerer Jahre am Strand von Pornic (Bretagne) durchgeführt wurden, gestatten, die Variationen der Populationen von *Chthamalus stellatus* nachzuweisen, die den tiefgreifenden Einflüssen des strengen Winters 1962-1963 zuzuschreiben sind. Im Verlaufe des Sommers 1965 war die Wiederherstellung der Populationen ungefähr vollständig.

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