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ECOLOGICAL STUDY OF THE INTERSPECIFIC RELATION AMONG LITTORAL SESSILE ANIMALS ON THE ARTIFICIALLY DENUDED ROCK[1,2]

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On the outer coast of Matsushima Bay, *Chthamalus challengeri*, *Balanus amphitrite albicostatus*, *Crassostrea gigas* (=*Ostera gigas*) and *Mytilus edulis* are found commonly in the intertidal part of cliffs and rocks, which are exposed to the waves and sometimes dry up during the low spring tide.

The distribution of the intertidal sedentary animals seems to be limited by the environmental conditions, but every species does not always occupy the whole of the area where the environmental conditions are suitable for their growth. Namely, animals arrange from the upper part to the lower part of the intertidal zone according to the environmental gradient, but the vertical range of the apparent distribution of *C. challengeri* and *B. a. albicostatus* is narrowed by the covering of *C. gigas*, and also the zones of *C. challengeri*, *B. a. albicostatus* and *C. gigas* are modified by the covering of *M. edulis*. It is usual in this vicinity that *C. challengeri* and *B. a. albicostatus* appear beneath *C. gigas* which is found below *M. edulis* (Hoshiai 1958).

As it is necessary to ascertain whether the process of the covering mentioned above can reappear artificially, an artificially denuded rock surface was made for observation in May, 1956. In June, 1956, though only a few *C. challengeri* was scattered on the old shells of *C. challengeri* or of *C. gigas* and also several individuals settled on the shell of *M. edulis* in the upper part of the *M. edulis* zone, the dense population of *C. challengeri* appeared newly on the said denuded rock surface. In August, at the lower part of the newly formed *C. challengeri* zone *B. a. albicostatus* settled on the rock surface. In December, the spats of *C. gigas* (1–3 cm in shell length) became remarkably recognizable all over the *C. challengeri* zone. In April, 1957 small *M. edulis* was found around the rim of the shell of *C. gigas*. In May, 1958 *C. challengeri* decreased by the covering of *C. gigas*, although *M. edulis* increased and began to conceal *C. gigas*. In April, 1959 the zonation of this station

1) Contributions from the Marine Biological Station of Asamushi, Aomori Ken, No. 256.
2) Details of this work will be reported in another occasion in the present Bulletin.

changed to rather resemble that in May, 1956.

In May, 1956 another artificial denudation was performed on the vertical surface of a granite rock, on which *C. challengeri* had dominated at the upper part and below it *M. edulis* had formed a conspicuous zone. In June, *C. challengeri* was found at the denuded part, and then, not only its population density increased, but also its vertical range extended downward. The pattern of the newly formed *C. challengeri* zone did not change till May, 1957. In May, 1958 the shell of *C. challengeri* grew larger and the surface of the "*Chthamalus* bed" became uneven by making many clusters. Small spats of *C. gigas* were found at the upper part of the *C. challengeri* zone. *M. edulis* formed small patches on the "*Chthamalus* bed". Until April, 1959 the population density of *C. challengeri* remarkably decreased, though *M. edulis* increased and its patches became larger than in May, 1958. In the former experiment, *M. edulis* was already found in May, 1957, but in the present it had never been seen on the shell of *C. challengeri* till May, 1958. It should be noted that in the former case the small shell of *M. edulis* appeared at the rim of the *C. gigas* shell.

A further observation was attempted to study the interrelation between *M. edulis* and *C. gigas*. For experimental observation another granite rock was selected near the aforementioned rock. In a belt (10 cm in width) which was set on its vertical surface where *M. edulis* had flourished, *M. edulis* was removed and thus the covered *C. gigas* was exposed, and in addition the another denuded vertical belt was prepared adjacent to the exposed *C. gigas* belt. In June, 1956 *C. challengeri* was found on the denuded part, but no *C. challengeri* appeared on the shell of *C. gigas*, and therefore the *C. gigas* belt remained as exposed. In May, 1957 at the lower part of the newly formed *C. challengeri* belt *C. gigas* was found and few *M. edulis* settled; on the other hand, the exposed *C. gigas* belt had been completely covered by *M. edulis*. As the similar result was obtained from the observation performed from May, 1957 to May, 1958, it may be said that the shell of *C. gigas* is more suitable for settlement of *M. edulis* than that of *C. challengeri*.

To examine whether the change subsequent to the denudation depends upon the initially settled animals, other denudations were made on the said granite rock in August and in December, 1956. The observed change in the belt which was denuded in August was similar to that in the belt where the denudation was made in May. In the denuded belt which was prepared in December, *Balanus cariosus* was found in May, 1957, but no *B. cariosus* had attached to the shell of *C. challengeri* in the belts which were denuded in May and in August, 1956, and also no *B. cariosus* settled on the shell of *M. edulis* on this rock. The upper limit of the distribution of *B. cariosus* was lower than that of *C. challengeri*. In May, 1958 *C. challengeri* appeared between the upper limit of the normal vertical zone of *C. challengeri* and that of the present *B. cariosus* zone, but on the shell of *B. cariosus*

no *C. challengeri* was found. *B. cariosus* had grown and *M. edulis* attached to it in May, 1958. In April, 1959 distinct patches of *M. edulis* was found in the "*Balanus* bed". It seems therefore that *M. edulis* covers both *C. challengeri* and *B. cariosus* showing a similar process.

It may be said conclusively that the distribution of *C. challengeri* and *B. cariosus* is modified at the part where *C. gigas* or *M. edulis* are able to settle and grow, and also the zone of *C. gigas* disappears at the part where *M. edulis* is able to conceal it.

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