

main beach) and *Hemiplax hirtipes* (present at Howick), worms (not named by Oliver) and pelecypods, *Antigona* (= *Chione*) *stutchburyi* and *Tellina* (= *Macomona*) *liliana* (both present at Howick). The surface fauna included *Cominella lurida* (= *glandiformis*), *C. adspersa*, *C. maculosa* and *Monodonta* (= *Zediloma*) *subrostrata* all of which were present at Howick but also included *Cerithidia bicarinata* (= *Zeacumantus lutulentus*), and *Amphibola crenata*, both characteristic of a muddy sand and therefore understandably absent from Howick.

Thus the species associated together on the upper part of the lower beach at Howick are basically the same as those found grouped together on the sand banks of Otago Harbour and on a muddy sand beach at Tauranga.

It is interesting that at station 4 and to a much lesser extent at station 5 there was a mixed population, the species of the *Amphidesma australe*-*Nucula hartvigiana* association of the middle beach occurring together with species characteristic of the *Chione stutchburyi*-*Macomona liliana* association of the lower beach. It has been noted that distribution of these animals seems to be governed largely by the texture of the sand, and the fact that this mixed population was developed in an area where sand texture was intermediate between that of the middle and lower beach (see grade analysis) further emphasises this point. However, both the faunal composition and the sand texture at station 4 was considered to be much more like that of the middle beach than the lower beach, and even though several other physico-chemical factors suggested otherwise, station 4 was included in the middle beach region, the importance of sand texture outweighing, in the opinion of the author, that of the variant factors.

On the lower part of Howick's lower beach a *Dosinia subrosea*-*Macomona liliana* association was recognised. Other species included *Amphiura aster*, *Baryspira australis*, *Leanira* sp., *Podarke* sp., a goniadid polychaete, *Nebalia* sp., haustoriid, phoxocephalid and other amphipods, ostracods, and the several species previously mentioned as being ubiquitous on the lower beach. A *Dosinia*-*Tellina* (= *Macomona*) association on Cheltenham beach was described by Oliver (1923) though he only mentioned the dominant species which were the same as at Howick. However, Rainer (unpublished) recorded also *Leanira leavis*, *Aglaophamus macroura*, and *Balanoglossus australiensis* as common on the lower part of Cheltenham beach. Thus the association of species on the lower part of the lower beach at Howick were basically the same as the *Dosinia*-*Tellina* (= *Macomona*) association recorded for Cheltenham beach.

Rainer also noted *Chaetozone* sp. and *Magelona papillicornis* at E.L.W.S. on Cheltenham Beach. Comparison of specimens showed that the same two species existed at Howick, and, together with *Travisia olens*, *Oridia* sp. and *Sigalion* sp., formed at E.L.W.S. what probably represented the fringe of a sub-littoral association.

That the three main associations recognised at Howick have some validity is shown by the fact that the same or closely comparable groups of animals have been found associated together in the only other areas of sheltered sandy beach so far investigated and recorded for New Zealand.

#### (b) Zonation

After investigating the zonation on sandy beaches throughout the world, Dahl (1953) concluded that three zones, a sub-terrestrial, a mid-littoral and a sub-littoral fringe can be recognised on the basis of the occurrence of the larger crustaceans. In temperate regions the sub-terrestrial fringe harbours talitrid amphipods; the mid-littoral zone characteristically contains cirrolanid isopods; and the sub-littoral fringe is characterised by haustoriid, phoxocephalid, and oedocerotid amphipods. Though Dahl's classification was based on exposed sandy beaches, similar zones could be distinguished on the relatively sheltered Howick Beach.