Habitat and Living Space

A "habitat" means much more than the geographical locality of a plant or animal. For example, while one of the pipi's localities is "Auckland", its habitat — by contrast — is the "sort of place" this bivalve lives in: "the middle of sandy or silty intertidal shores, with more shelter than exposure". This distinction could be made for every species but man himself. For the human habitat, one could hardly give more than the locality "Auckland" or wherever he is found: for man bestrides the narrow habitat divisions like an ecological Colossus. Though not a giant among animals, he is big enough not to be blown away by the wind, or stick to the surface film, or need crevices to take refuge in. Not very specialised in body, he has cut himself off from much of the environment by his culture and technology. Though man can live in a jungle tree-house or a cabin on a coral reef, his real habitat is the paved urban area where he has indelibly left his mark.

Much of the rest of the land, such as farms and planted forests, has also been transformed by man. But the natural habitats and their vegetation still cover large areas of New Zealand. On a world map, the vegetation zones and their associated animals form great and widespread "biomes". Travellers and naturalists were early impressed with the regular sequence of vegetation zones: equatorial forest, warm temperate evergreen, deciduous, pine forest, tundra, replacing each other with increasing latitude and also, in a similar way, with increasing altitude.

The zoning of habitats can be seen in the cross-section of Mount Egmont (see Fig. 1) and the adjacent coast and sea. The first great habitat, the open sea, is characterised by drifters and swimmers. Nothing is permanently sited or fixed down. The plants are microscopic and elementary, and they live in the surface lighted zone of about 50 m. A rain of nutrients and organic

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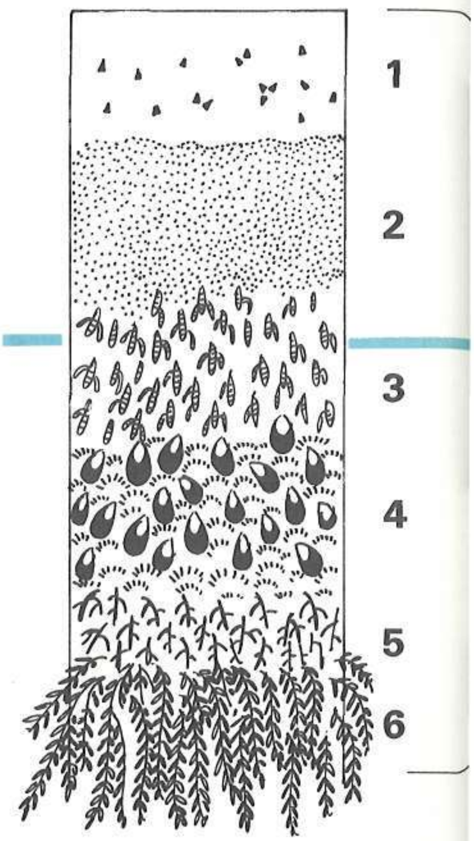
Richard Silcock



debris is contributed to the darker layers where photosynthesis cannot go on.

The most impressive stratification is seen on land: from sand-dunes, across grassland, up through lowland rain forest, montane forest, scrub and tussock, fell-field and scree vegetation to bare rock.

At the boundary between land

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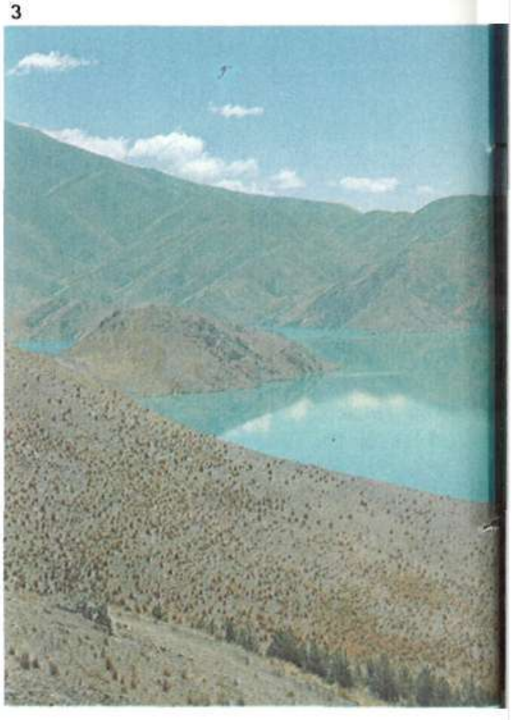

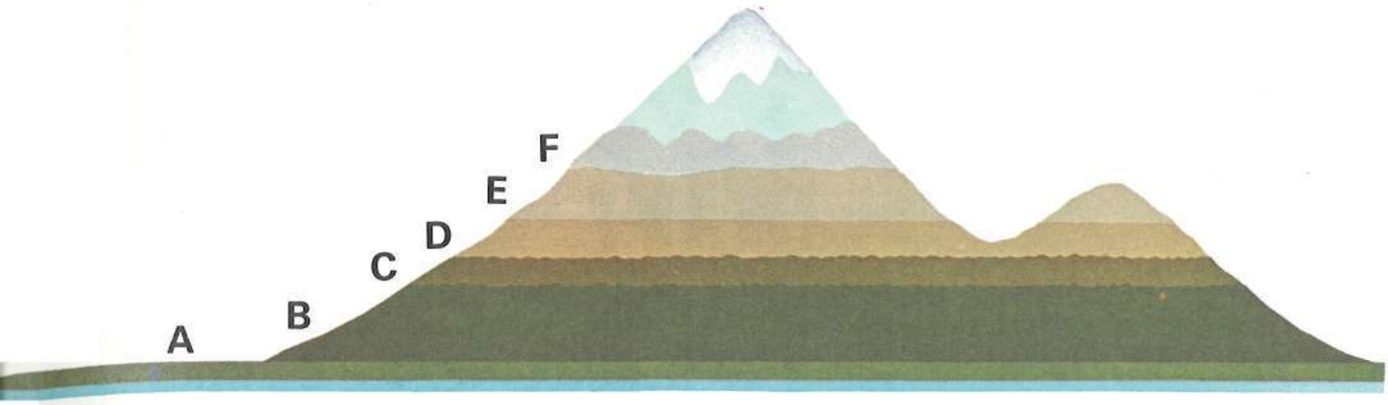

Fig. 1

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J. E. Morton/David Cowe

and sea, where the tide-line fluctuates twice daily, a continuous linear habitat runs around the whole landmass. The shore and shallow sea formed the evolutionary cradle of almost all animal life. Nearly all the great classes of animals are well represented there, in a diversity and abundance without parallel elsewhere. Not only the plants but many of the animals are permanently sessile, or fixed down during adult life. Zonation is both intensely developed and narrowly compressed in the girdle between tides. In 2.4 m of shoreline a range of different life forms may be found which is comparable with those spread through 2,400 m on a mountain slope. (See Fig. 1.)

There is another linear habitat, also too narrow to show on an ordinary habitat map, where rivers and streams radially intersect the landmass and only occasionally widen into lakes. Life in fresh water will vary with steepness and speed of flow, just as intertidal habitats will differ with changes from hard to soft, or wave-exposed to sheltered, shores.

The major biomes on land are utterly dominated by green vegetation. By their prominence and large biomass, the higher plants call the tune. They give the habitat its pattern and style, and produce a biosphere that is far more visible than the dead lithosphere it clothes. On the seashore as in the open sea, the plants have shown far less evolutionary initiative. Even when — as with the bull-kelp and bladder-kelp — algae grow to 30 m long, they are relatively light in bulk and of simple, elementary construction.

On the land, by contrast, it is the animals that are so relatively small in biomass as hardly at first to be noticed. Indeed the botanists have

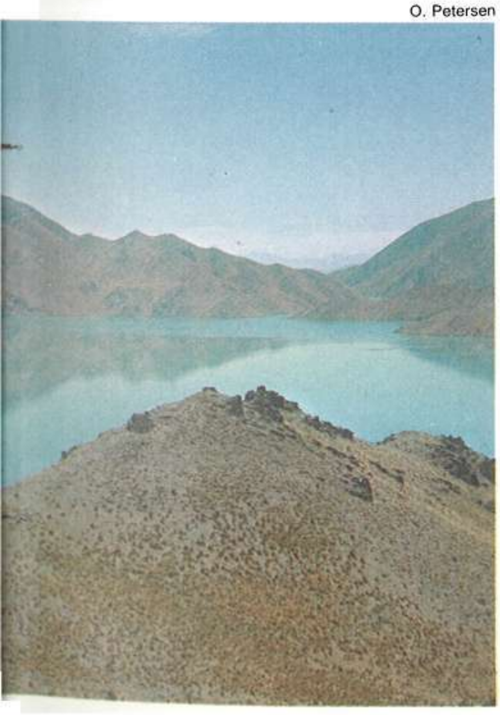
1 The zoning of habitats may be seen in this cross-section of Mount Egmont as compared with the intertidal shore. The pastureland (A) of the coastal plain gives way to lowland rain forest (B). Mountain totara and kamahi (C) come next, followed by mountain cedar (D). In the higher, colder areas scrub and tussock (E) merge into herb and fell-field (F). Just as great a zonation occurs in the narrow area at the land's edge where the tideline fluctuates. On this intertidal shore are found periwinkles and lichens (1), barnacles (2), mid-littoral algae (3 and 5), mussels (4), and the large brown algae *Carpophyllum* (6).

2 A typical high-country habitat agreeably modified by man. This farm is at Dumbarton near Roxburgh in Central Otago.

3 An artificially-created lake develops a new kind of habitat. Here at Lake Benmore in South Canterbury afforestation is at an early stage on the rocky slopes.

4 An intertidal rock pool contains a great variety of plant and animal life.

O. Petersen



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Brian Enting

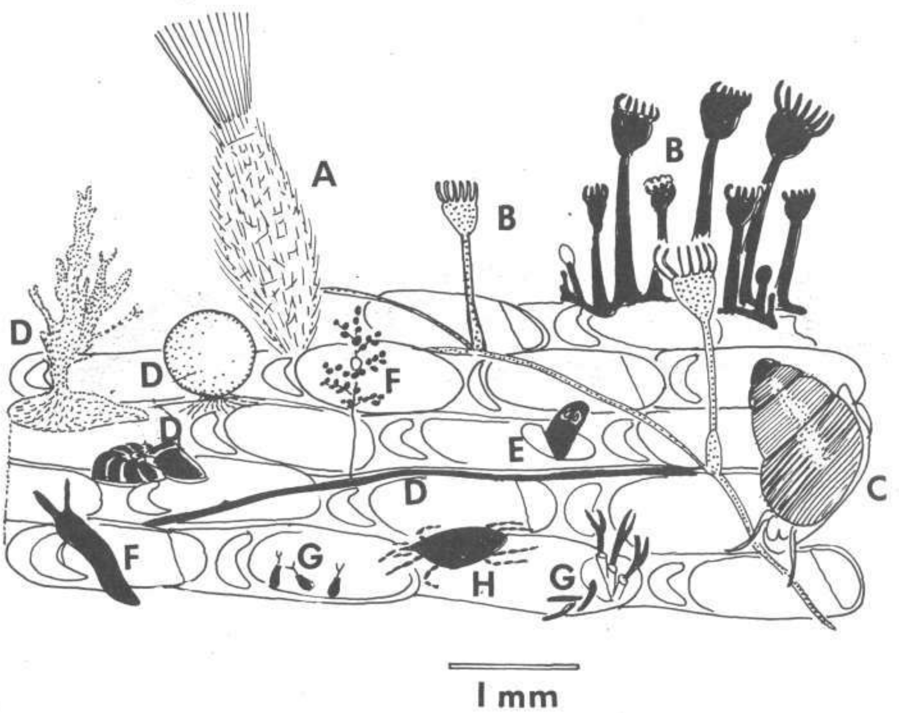

Fig. 2

J. E. Morton after Dennis Gordon

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frequently treated plants and their relations with the environment as a story in themselves. No animal ecologist could work like this. On the seashore in particular, the plants and animals are so intimately related as to defy a tidy sharing out between botanists and zoologists. Indeed, few biologists of any sort would be content to employ such separate titles today.

Rich Confusion

For a closer study of a habitat, and especially of its animals, one must move beyond maps and penetrate the area itself. In almost any habitat, the first impression is of diversity and apparent untidiness. After the neat and stratified textbook diagrams, there is a bewildering detail and range of life forms. This is a part of biology that ought never to be simplified away, as could be possible with the more austere sciences of physics and chemistry, with their economy of detail and seemingly more comprehensive laws. One marine ecologist has applied Alexander Pope's lines to the seashore habitat: "Not chaos-like together crushed and bruised,/ But as the world harmoniously confused". It is for the field ecologists to trace out, from this rich confusion, the basic harmonies and themes.

Often the bodies of animals and plants, rather than the non-living lithosphere, provide the platform for other species. In a rain forest or coral reef, the whole intricately layered substrate is inter-related. Within a habitat itself, internal stratification of every kind and degree may exist. Indeed, the term "habitat" is used with a widely varying scale of reference: for a kauri forest or a salt marsh that can be taken in with a sweep of the eye, or for the complex of species in a kelp holdfast, or in an empty barnacle shell or polyzoan (see Fig. 2).

Obviously, though they live in the same habitat, no two species will have quite the same "environment". This is a special term in which the ecologist includes the whole range of external factors that bear upon an individual or a species. There is first the physical "place to live in", whether inanimate or part of other living things. Second is the "weather", the sum of the physical and chemical processes going on around it. Third is the influence of other animals and plants, whether as prey or predators, or as competitors for resources such as food and living space. Each species will react to this complex in an individual way, and will be intimately shaped by and adapted to it.

On a shorter scale, the build-up of the community beneath a low-tidal boulder can be studied over 12 months. A clean basalt slab shows a sequence of barnacles, tube-worms, polyzoans, compound and simple ascidians, and finally sponges. Fibrolite plates attached to wharf piles develop a similar succession. In two or three weeks, a beaker of water in which hay has been infused will show a protozoan succession, from flagellates to *Paramaecium*-like ciliates, then carnivorous ciliates

2

NZ Forest Service

1 A small community on the empty chitinous skeleton of a polyzoan or sea mat includes a small vase-sponge (A), two sorts of entoproct polyzoan (B), the snail *Eatoniella* (C), four sorts of foraminiferan (D), a branched sessile ciliate (E), flatworms (F), sessile ciliates (G), and a mite (H).

2 The artificial creation of habitats such as exotic pine forests has led some conservationists to complain that these will eventually change the character of New Zealand's native forests and thus affect bird and animal life. But such forests provide a continuous supply of timber, prevent erosion, and protect the watershed. Shown here is the Waihura cutting section of the Kaingaroa State Forest.

3 Cosmopolitan communities are familiar groupings which are found in similar habitats throughout the world. Although related species may represent each life-form in different parts of the world, the community remains essentially the same. Fig. 3 shows the New Zealand representative species of a cosmopolitan salt-meadow community (1-7) and bivalves of adjacent sand flats: 1 *Plantago coronopifolia;* 2 *Samolus repens;* 3 *Selliera radicans;* 4 *Salicornia australis;* 5 *Cotula coronopus;* 6 *Assiminea vulgaris;* 7 *Ophicardelus costellaris;* 8 *Chione stutchburyi;* 9 *Macoma liliana;* 10 *Nucula hartvigiana.*

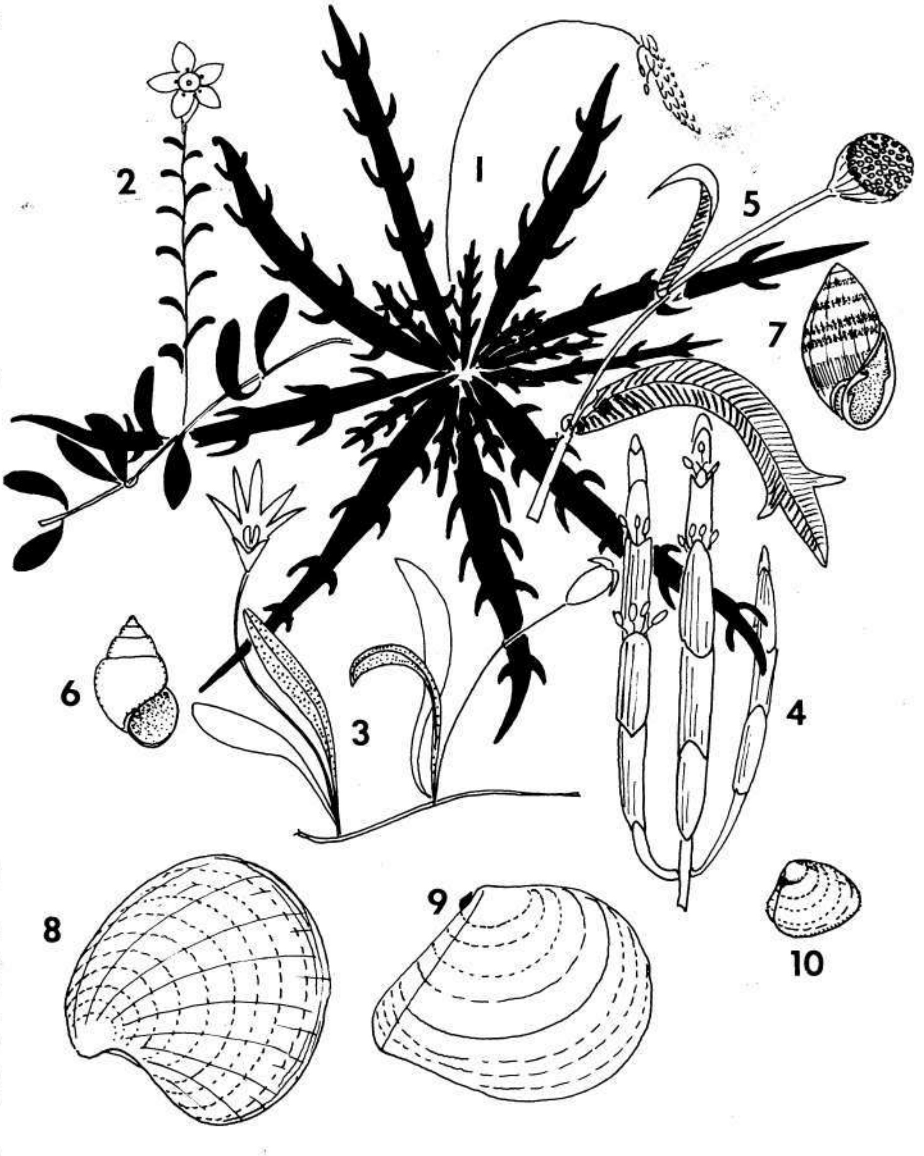

Fig. 3

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J. E. Morton

feeding on the earlier ones, and finally Amoebae.

Each dominant species in turn does something to the habitat, or takes something from it, rendering it more suitable for successors and paving the way for its own replacement. The community — like the individual — has thus a phylogeny or life history.

The word "community" introduces the most familiar but still the most disputed concept of ecology. It is easy to show statistically that certain species are regularly and predictably found together. There are innumerable such associations throughout Earth. Frequently the same genera or life forms will occur, represented in different parts of Earth by separate but "homologous" species. On any mid-tidal shore with rock oysters, there will also be a thaid boring welk, a red mite, a green worm *(Eulalia),* a crevice-dwelling marine centipede, and a peanut worm *(Dendrostomum).* The salt meadow plants shown in Fig. 3 are another cosmopolitan group. So too, on sheltered sand-flats, are the bivalves *Macoma, Nucula* and the cockle, and also the lug-worm *Arenicola.*

The real authenticity of the community comes not from any complete coincidence in species, but from its repetition in widely different parts of Earth. It is as if there were a number of dramas — *Hamlet, Othello, Macbeth* — with the same roles played out by innumerable local casts.

Why should these familiar groupings repeatedly turn up in similar habitats? It has sometimes been assumed that communities are linked together by real organic bonds, and are really "super-organisms" having — like cells and individuals — separate parts, divisions of labour, growth, succession, senescence and death. Few ecologists today would accept this extreme view. Most would believe that the bonds uniting a community are no more organic and intimate than those of the human economic system, which — built as it is on competition and tensions — can yet appear to function as an entity.

Many plant and animal associations, such as those shown in Fig. 2, are probably aggregations with nothing in common but a preference for the same substratum. The bivalves and lug-worm live independently of each other, wholly reliant on the sea and its resources beyond their refuge on the ground.

Resemble Villages

Unlike such "dormitory-suburb" aggregations, there are other communities with the close-knit interdependence of a village. The best examples are the "ecosystems" with their "pyramids of numbers" and successive trophic levels. Ecology books show many familiar examples. In the bottom tier, smallest in size but greatest in numbers, are primary producers, microscopic green algae. Herbivores or primary consumers, such as the mayfly larvae, which might form the next tier, feed on the algae. Above these could be

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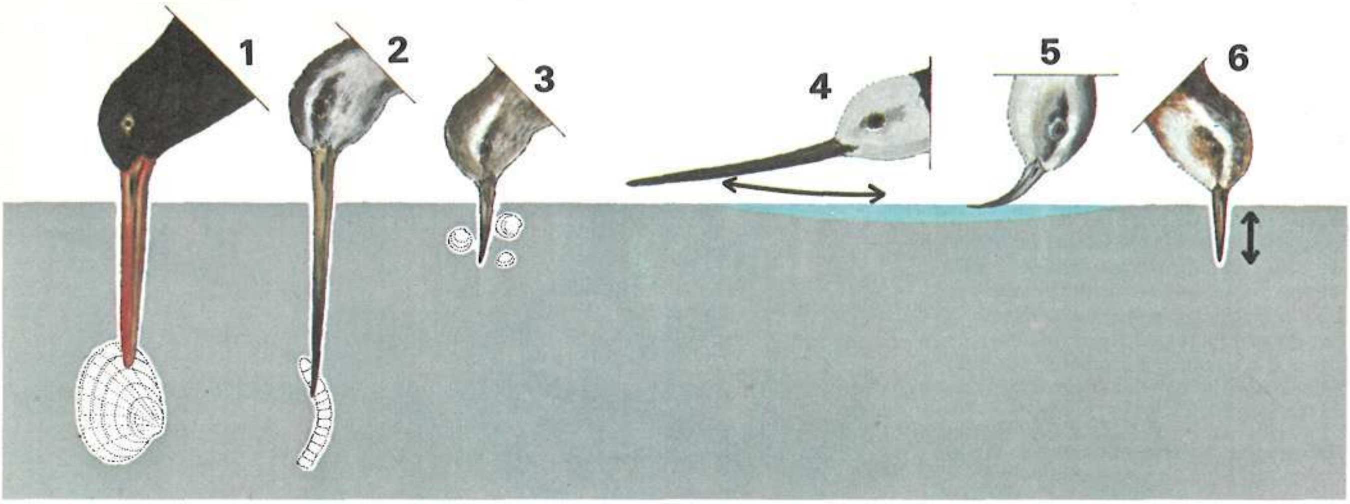

J. E. Morton/David Cowe

Fig. 4

three tiers of carnivores, progressively larger in body and fewer in numbers: dragonfly nymphs, galaxiid fish, and the kingfisher. As well as producers and consumers there are also reducers: the bacteria and fungi that decompose the dead remains of each of the other classes and return organic nutrients to the environment.

Why should a habitat contain so many kinds of plants and animals? Why could not there have been one or a very few kinds of generalised, all-purpose "living stuff"? It is possible to imagine, first, a single plant species as primary producer, with bacteria to decompose it and recycle its nutrients after death. The food chain could then have been lengthened by introducing a single herbivore and one carnivore species. But the food webs actually found are far more complicated than this, with sometimes four or five species alternating or operating together at the same trophic level. Looked at more carefully they will be found taking different resources.

Many closely related wading birds live on intertidal flats (see Fig. 4). The oystercatcher's stout bill is adapted to plunge into the ground up to the haft and take the flesh of a bivalve while leaving the shell where it is. The godwit inserts its slender bill for worms. Nearer the surface the shorter-billed eastern knot probes for small molluscs. The small red-necked stint uses its bill with a sewing-machine action for catching sand crustacea. The pied stilt skims with its slender bill in surface standing water. The wrybill has a unique surface-foraging action with its sideways twisted bill, not yet fully understood. This tendency to diverge and specialise is a commonplace of evolution.

The separate species are all similar, but with differences of adaptation to exploit slightly different resources in the same habitat. And where two closely-related species occur together in the same territory, they will tend to diverge from each other and specialise more than when existing alone. Each lives most efficiently by becoming a specialist on one resource rather than a Jack-of-all-trades with a mediocre performance upon many. Each specialist is said to occupy a separate niche. This is not a physical situation, but an abstract expression of its relation to the habitat, and its place and role in the community. A complex habitat offers a profusion of niche possibilities, some of them subtle and hard to foresee in advance. For niches are not just empty roles waiting for a player. They are discovered and moulded by the actors themselves, with their genetic resources and adaptive versatility and are shaped under the selection pressure of a competitive environment.

Not only do species tend to evolve and increase their fitness, it is also a central truth of biology that habitats and communities will increase in complexity. **J. E. M.**

1 These closely-related wading birds of intertidal flats have diverged and specialised so as to exploit all the resources of their shared habitat. Each bill is adapted for different uses and on different prey. The oystercatcher (1) concentrates on bivalves, the godwit (2) on worms, the eastern knot (3) probes for small molluscs, the pied stilt (4) and the wrybill (5) forage in surface water but in different ways, and the red-necked stint (6) uses its bill with a sewing-machine action to catch sand crustacea.

2 A rock face above tide level at an early stage of plant colonisation, with black and grey lichens and the mirror-leaf *Coprosma repens*.

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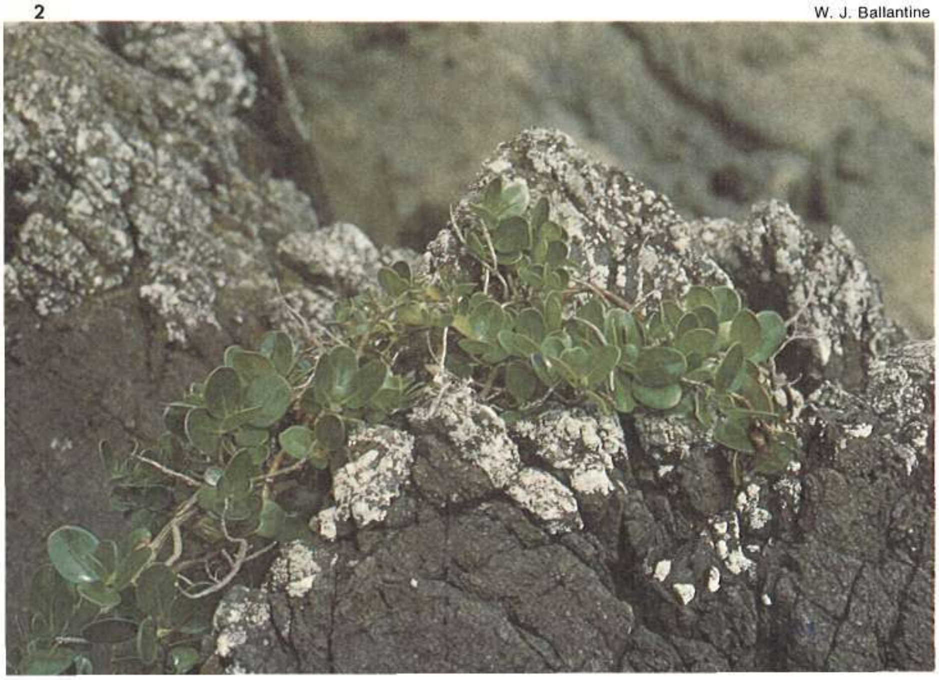

W. J. Ballantine