BLOW-INS FROM THE BLUE FLEET

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SOMETHING IN THE WATER

When the First Fleet sailed down the eastern Australian coastline from the Tropic of Capricorn to Botany Bay, progress was no doubt aided by a remarkable ocean feature, the East Australian Current. Thanks to the earth's rotation sloshing the world's oceans onto the eastern flanks of the continents, some thirty million cubic metres of tropical Pacific waters per second are pushed southwards by this current, in a band of water up to 100 km wide and 500 m deep. The Current does more than boost local water temperatures. It also bulk-transports components of a tropical marine ecosystem. It enables coral reefs to survive well south of the Tropic of Capricorn. It brings larvae of coral-dwelling butterflyfish to the New South Wales South Coast. And sometimes, in summer, its swirling, southernmost eddies bring a taste of the tropics all along eastern Tasmania's otherwise very temperate coastline.

This article isn't about the First Fleet, but the Blue Fleet. Captain Cook would not have heard of the term, and you may not have either. It was coined by pioneering oceans biologist Sir Alister Hardy, author of the 1956 classic New Naturalist book *The Open Sea*. The Blue Fleet was his apt descriptor for the assortment of strange creatures that make a living sailing the surface waters of the warmer reaches of the world's oceans, and which are sometimes brought together in vast numbers in eddies and along ocean fronts by the combined effects of wind and current, to be carried polewards, often well beyond their normal range. Scientists call this strange realm, this interface between seawater and air, the pleustal zone. Its inhabitants are neither plankton (which drift beneath the waves) nor nekton (which swim beneath the waves). They are pleuston. And many of them are blue.

BLUE JELLIES

The Blue Fleet is at home out on the open sea, but winds and currents sometimes conspire to bring them ashore. The widespread stranding of one of the most characteristic of these blow-ins, the bluebottle *Physalia utriculus*, is perhaps the best-known harbinger of the Blue Fleet's arrival in Tasmania. Its scientific name means 'little womb bladder', which I suppose is as good a moniker as any, given the physical appearance of the desiccated gas-filled float, which is often all that remains of the hapless bluebottle once cast ashore. Strewn along the tideline, sometimes in their thousands, they are a familiar feature of Tasmania's east-coast beaches; last summer they even turned up in Taroona. But even when we find them freshly stranded, as on Schouten Island last summer (Plate 1), it is difficult for us terrestrials to appreciate the alien life that a bluebottle must lead, out on the ocean waves. So here's a short introduction.

The typical eastern Australian bluebottle has a single retractile fishing tentacle, which, along with its smaller size, distinguishes it from the much-feared Portuguese man-o'war, *Physalia physalis* (the 'bladder bladder'). Thankfully for local beachgoers, a bluebottle's stinging cells

Plate 1. A bluebottle *Physalia utriculus* stranded on Schouten Island, January 2010 (photo: S. Grove)

(nematocysts) are less potent than those of the Portuguese man-o'war – a species now considered to be confined to the Atlantic. Out on the open ocean a bluebottle lives the life of a fisherman, dangling its tentacle into the water to entrap small fish and their larvae. Except, whereas fishermen need to equip themselves with boats and tackle, the bluebottle has all the necessary components for floating, transport, fishing and processing rolled into one living entity. But on the other hand, that entity is not a single organism, so in effect each bluebottle is more like a fishing cooperative, or maybe a factory ship.

In formal taxonomic terms, bluebottles are siphonophores, a group of colonial marine organisms that form part of the class Hydrozoa, itself part of the phylum Cnidaria. They are only distantly related to other cnidarians such as the true jellyfish (Scyphozoa) and the box-jellies (Cubozoa). Most siphonophores live in the ocean's depths, where their colonies can form beaded strings of stinging jelly sometimes tens of metres long – akin to self-replicating, autonomous long-line fishing apparatus. But in bluebottles, individual members of the colony are highly differentiated to serve different functions. One member forms the air-filled float, while the others are specialised for feeding and digestion, or for reproduction, or to form the stinging, fishing tentacle.

A bluebottle may lack a brain, but it is far from being a mere passive drifter. Its float is not hemispherical, but elongated, with an upper margin that is pinched, rather in the manner of a cornish pasty or apple turnover. Remarkably, it can alter the orientation of its float, the better to catch the wind. What's more, somehow a bluebottle is able to tip itself over onto its side to re-wet its float, first one side and then the other. It may do this every few minutes, depending on ambient conditions of heat and humidity. So is a bluebottle a colony of individual polyps or an individual organism in its own right? It's a question that has been pondered by some of the finest scientific minds for well over a century, yet remains a moot point. In effect, they lie at the boundary between the simple colonial world and that of more complex multicellular animals. This may be worth contemplating the next time you casually 'pop' those 'little womb bladders' as you stroll along the beach.

Bluebottles have some colonial hydrozoan relatives amongst the Blue Fleet, belonging to the anthomedusans rather than the siphonophores. Their vernacular names, by-the-wind sailor and blue-buttons, may charm us more than their equivalent scientific names, *Velella velella* and *Porpita pacifica*, but mean much the same thing ('little sail'; and 'brooch of the Pacific', respectively). Both species are regularly washed ashore in eastern Tasmania amongst the wreckage of bluebottle armadas, but, being much smaller and less robust, they tend to melt into the sand more quickly and are readily overlooked. Still, a freshly stranded by-the-wind sailor is a marvelous sight to behold, as I was fortunate to do last summer on Schouten Island (Plate 2). While bearing a closer resemblance to jellyfish, a by-the-wind sailor has a gas-filled float that keeps it perched upon the sea surface rather than beneath it. The term 'float' underplays its second major function, which is as a sail. Unlike the bluebottle's air-sac, the float is thin, semi-rigid and upright – not unlike a boat's sail, and oriented on a diagonal to the long-axis of the disc. In technical terms, the sail meets the specifications of a 'low-aspect-ratio aerofoil' – a design that favours seaworthiness and stability. This apparently makes it hard to capsize a by-the-wind sailor: it is stable over a range of attack angles from 28 to 87 degrees. Should you find yourself adrift in the East Australian Current, give it a go.

A by-the-wind sailor has only one immovable sail to play with, so is at the mercy of the prevailing winds. But *populations* of by-the-wind sailors do have a bit of control over their destiny, a phenomenon that Hardy referred to as "the evolution of unconscious navigation". Populations can comprise mixtures of both 'right-handed' and 'left-handed' forms, one being the mirror image of the other in respect of the orientation of the sail-axis relative to the long-axis of the disc. This means that one form will tend to be blown towards the northeast in an easterly wind, while the other will be blown towards the southeast; similarly, one will be blown towards the northwest in a westerly, while the other heads towards the southwest. In the centre of the Pacific Ocean, both forms co-occur, but one form tends to predominate over the other elsewhere in the Pacific, depending on the time of year and on the direction of the prevailing winds typical of the season. It would be interesting to see whether both forms occur together in mass strandings in Tasmania; theory would suggest not.

Blue-buttons look rather like by-the-wind sailors with their sails removed (Plate 3). To all intents and purposes they behave like a sail-less by-the-wind sailor would be expected to behave, drifting with the current – they have even appeared at Taroona. Both species lack the bluebottle's fishing tentacle because they feed on microplankton, caught

Plate 2. A by-the-wind sailor *Velella velella* stranded on Schouten Island, Jan. 2010 (photo: S. Grove)

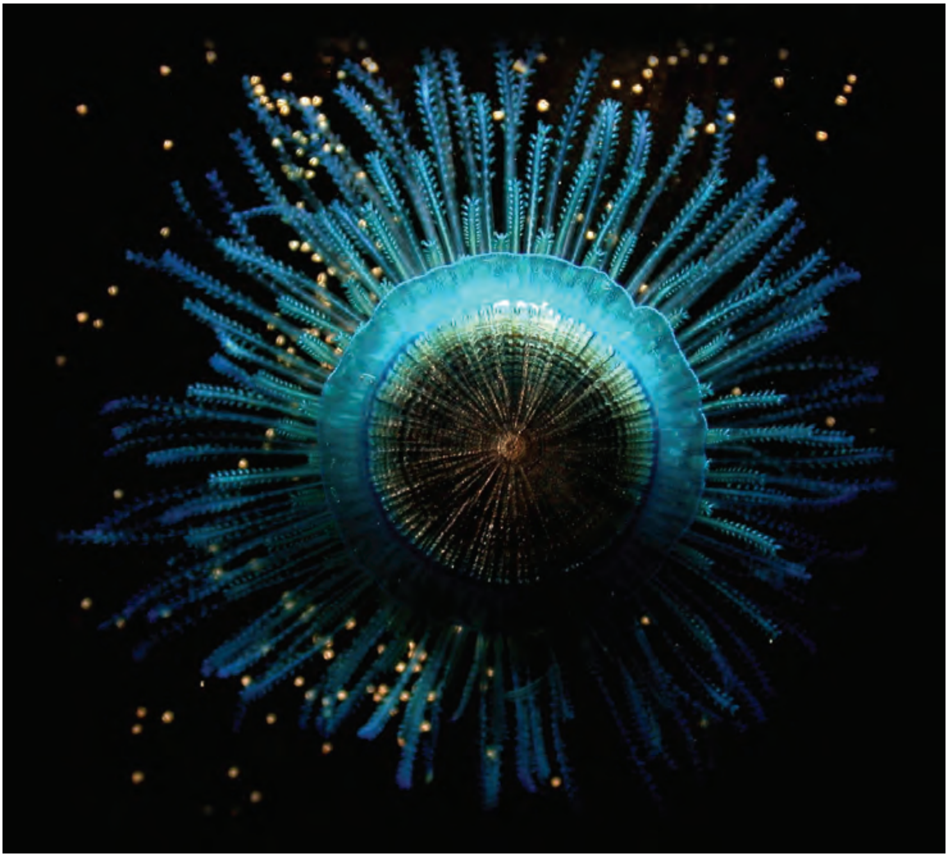

Plate 3. A blue-buttons *Porpita pacifica*, captured live in the waters of Moreton Bay, Queensland (photo: Lisa Gershwin)

by means of smaller tentacles laced with stinging cells. The disc itself is made of keratin and is dead (like our fingernails), acting as a floating substrate for the polyp colony underneath.

Bizarrely (from a human perspective), these creatures engage in alternation of generations. The asexual stage is the one I have just described. The sexual stage that follows it is a planktonic medusa that may be either male or female, and which drifts through the sun-lit surface waters, enlisting the services of algal cells (zooxanthellae) to capture energy from sunlight.

BLUE SLUGS

Despite their predatory existence, the three blue 'jellies' are themselves the source of sustenance for further members of the Blue Fleet – the Pirates of the Pleuston, if you like. Like the jellies, they too may end up stranded on Tasmanian beaches, sometimes, but not always, in each other's company. The first of these is the blue ocean-slug *Glaucus atlanticus*. Its name means 'the Atlantic bluish-green one', because it was first described from specimens collected in that ocean, but it occurs worldwide in warmer seas. It made the headlines (okay, the inside pages of the local papers) in January 2007 when it put in its first, and so far only, known Tasmanian beach appearance, at the Bay of Fires. It's a stunning beast, in more ways than one. For a start, it's bright blue with a dash of silver when seen from above, while from below it's predominantly silvery-white (Plate 4). Although it's a sort of sea-slug (an aeolidian nudibranch in technical terms), it is often called a 'sea-lizard', because it seems to have long pointy-fingered fore-limbs and shorter similarly endowed rear-limbs. The 'fingers' on these lobes are technically known as cerata, and they are the second reason for calling this creature stunning. The tips of the cerata are laced with stinging cells, aggregated into cnidosacs that can deliver a formidable sting if touched.

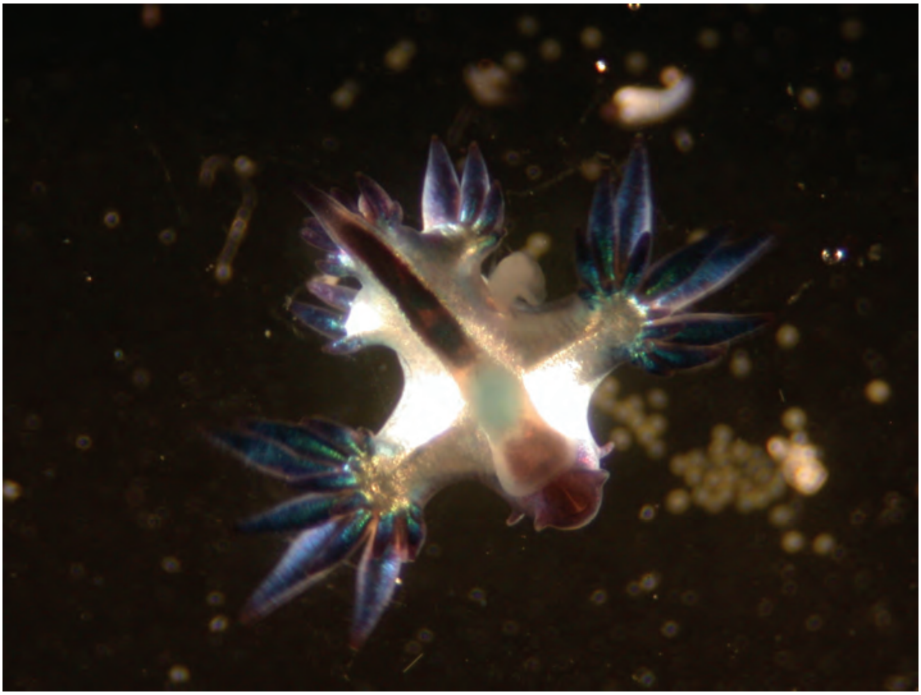

Plate 4. A blue ocean-slug *Glaucus atlanticus*, captured live in the waters of Moreton Bay, Queensland (photo: Lisa Gershwin)

A clue as to whence the blue ocean-slug gets its sting comes from its diet – it's a specialist predator of bluebottles and Portuguese men-o'war, though it will also eat by-the-wind sailors, blue-buttons and other members of its own species if it happens to encounter them. A blue ocean-slug has a gas-filled float in its stomach, allowing it enough buoyancy to almost cling to the sea-surface from beneath – an ideal vantage-point for scouting for bluebottles, though the ploy leaves it at the mercy of the currents and winds. When a blue ocean-slug eats one of these creatures, its stinging-cells pass intact through the gut wall into the slug's body cavity, from where they are somehow translocated to the cerata. The high concentration of these second-hand cells in the cnidosacs means that it's possible to get a much more painful sting from a blue ocean-slug than from a bluebottle – so if you see one, look but don't touch. Presumably they help the creature defend itself from predatory fish.

Having eaten its fill, a female blue ocean-slug may inflict a final indignity on the bluebottle by laying its eggs on the carcase. Since it's such a rarity in Tasmania, all records of strandings will increase our knowledge of its distribution (Figure 1a) – so please let me know. It would help to either collect the specimen or take a photo, because there's the possibility of detecting a further species, the margined ocean-slug *Glaucus marginatus*. This species shares the blue ocean-slug's habitat and is very similar in appearance. It has recently turned up in Victoria, so why not Tasmania next?

VIOLET SNAILS

The final members of the Blue Fleet are also predators on the jellies. They are the voracious violet vagrants better known as violet-snails (Plate 5), a group of gastropod molluscs closely related to the benthic anemone- and coral-feeding wentletraps. Although they eat nothing but jellies, their shells can survive at sea and on beaches long after their makers' deaths, so they're not uncommonly found by beachcombers even in the absence of their prey. Globally there are five species of violet-snail, but the standard species washed up in Tasmania is the common violet-snail *Janthina janthina* (meaning simply 'the violet-blue one').

These snails are found worldwide in warmer seas; in Tasmania they are more usually recorded from the East Coast (Figure 1b). Their thin globular shells, delicately tinted in shades of light-to-dark blue or purple, are a delight to behold, and because of their unusual colour they stand out strongly when encountered among beach debris. I eagerly await their addition to the Taroona shell list – it can only be a matter of time.

Plate 5. A common violet-snail *Janthina janthina* complete with bubble-raft stranded on Schouten Island, January 2010 (photo: S. Grove)

A violet-snail keeps itself at the sea-surface by means of a raft made of dozens of bubbles, and are sometimes beached in this condition, as on Schouten Island last summer (Plate 5). To make its raft, bubbles of air are captured and bound in mucus by the mollusc's foot, each 'gulp' taking about ten seconds. But this only explains how a violet-snail stays at the surface. How did it get there to take its first gulp? The partial answer is that the planktonic veliger larval stage produces a long mucus stalk with a ball of gas-filled bubbles at the end. This acts like a drag-line and buoy, raising the larva to the surface, where it metamorphoses into the adult snail. Of course, this raises the as-yet unanswered question as to how the veliger gets gas into its own buoy in the first place.

Most probably, violet-snails of any species will feed on whatever Blue Fleet jellies come their way, since they have no control over where they drift and what they might bump into. They also lack eyes (unlike their wentletrap ancestors), so must do everything by touch or in response to chemical cues. When a violet-snail bumps into a bluebottle, it extends its head, everts its proboscis and bites into the prey with its radula. If the bluebottle is a large one, it may have to abandon its bubble raft and climb aboard to devour it, presumably making sure that it doesn't pop the bluebottle's float before it has made itself a new raft. The violet-snail eats the stinging nematocysts along with the rest, but unlike the blue ocean-slug, does not preserve these for its own defensive use.

There is another species of violet-snail that links eastern Tasmania to the tropics, and it's a real gem – the lesser violet-snail *Janthina exigua*. I was surprised to discover that its scientific name means 'meagre violet-blue one', because to my mind it's anything but meagre. Space doesn't permit me the purple passages I would like to write about this purple passenger. It is indeed small compared to the common violet-snail, but what it lacks in stature it makes up for in the intensity of its violet coloration (Plate 6). It also differs in having a taller, more inflated spire. The two species also differ slightly in their biology. While both are hermaphroditic, the common violet-snail expels its veliger larvae (about a thousand of them) directly into the ocean, whereas the lesser violet-snail attaches its eggs (up to 44,000 of them) to the underside of its bubble-raft. Whether these different strategies translate into global differences in adult abundance is unclear to me, but the lesser violet-snail is certainly a rare beast in Tasmanian waters. Previous records that I'm aware of are all from Flinders Island, but last summer I struck gold (or perhaps amethyst) when I found a single specimen amongst hundreds of common violet-snails freshly beached on Schouten Island (Figure 1c).

WHY IS THE BLUE FLEET BLUE?

So why are members of the Blue Fleet blue (or violet)? One theory has it that the coloration is like sunscreen – built-in protection against the intense ultraviolet light at the tropical sea-surface. But this seems misguided, at least for violet-snails. A recent study of the astaxanthin pigments that make them violet demonstrated that they absorb light most strongly in the wavelength range of 630-660 nm, which corresponds to red light, not ultraviolet. It's also noticeable how the coloration of bluebottles, blue ocean-slugs and common violet-snails is more intense when seen from above than from below. This is a classic countershading strategy. The animals blend into the colour of a dazzling sky when viewed from below, helping to avoid being spotted by predatory fish or turtles; while from above, they blend into

Plate 6. The shell of a lesser violet-snail *Janthina exigua* raft stranded on Schouten Island, January 2010 (photo: S. Grove)

the colour of the deep blue sea, reducing the risk of being snacked upon by overhead birds. The blue ocean-slug takes things a step further by mixing in a splash of silver among the blue of its upper surface, all the more resembling the glistening sea-surface.

AN UPSIDE-DOWN WORLD ATOP THE WAVES

There's one more remarkable attribute that all these creatures share: they all live upside-down, unlike their benthic relatives. It's easy to see why violet-snails would cling upside-down to the undersides of their bubble rafts, but less clear why the blue ocean-slug chooses to cling to the sea-surface in this position; but it does. As for the jellies, their upside-down-ness may be obvious to an evolutionary biologist familiar with the developmental stages of cnidarians, but for the rest of us, it's a matter of trying to imagine how the original medusa or polyp must have had to flip over to suit a lifestyle on top of the waves rather than beneath them. It's as though they capsized in reverse.

BRING ON THE BLUE FLEET!

It's said that climate change is progressively strengthening the East Australian Current, enabling its fingers to more regularly reach out towards Tasmania and contributing to higher-than-average rates of warming of our East Coast waters. There are very many very special life-forms that will lose out as the waters warm and nutrient levels plunge, and the natural world around us will be the poorer for their loss. But I for one will take some consolation in knowing that blow-ins from the Blue Fleet will increasingly be gracing our Tasmanian shores with their presence.

ACKNOWLEDGEMENT

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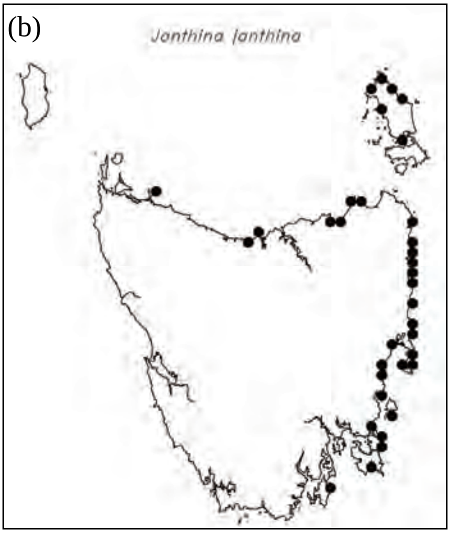

Figure 1. Tasmanian distribution maps (normalised by 10 km square) for the mollusc members of the Blue Fleet, based chiefly on the author's personal records, as well as those of the Tasmanian and Queen Victoria Museums, Margaret Richmond and others (a) blue ocean-slug *Glaucus atlanticus*; (b) common violet-snail *Janthina janthina*; (c) lesser violet-snail *Janthina exigua*