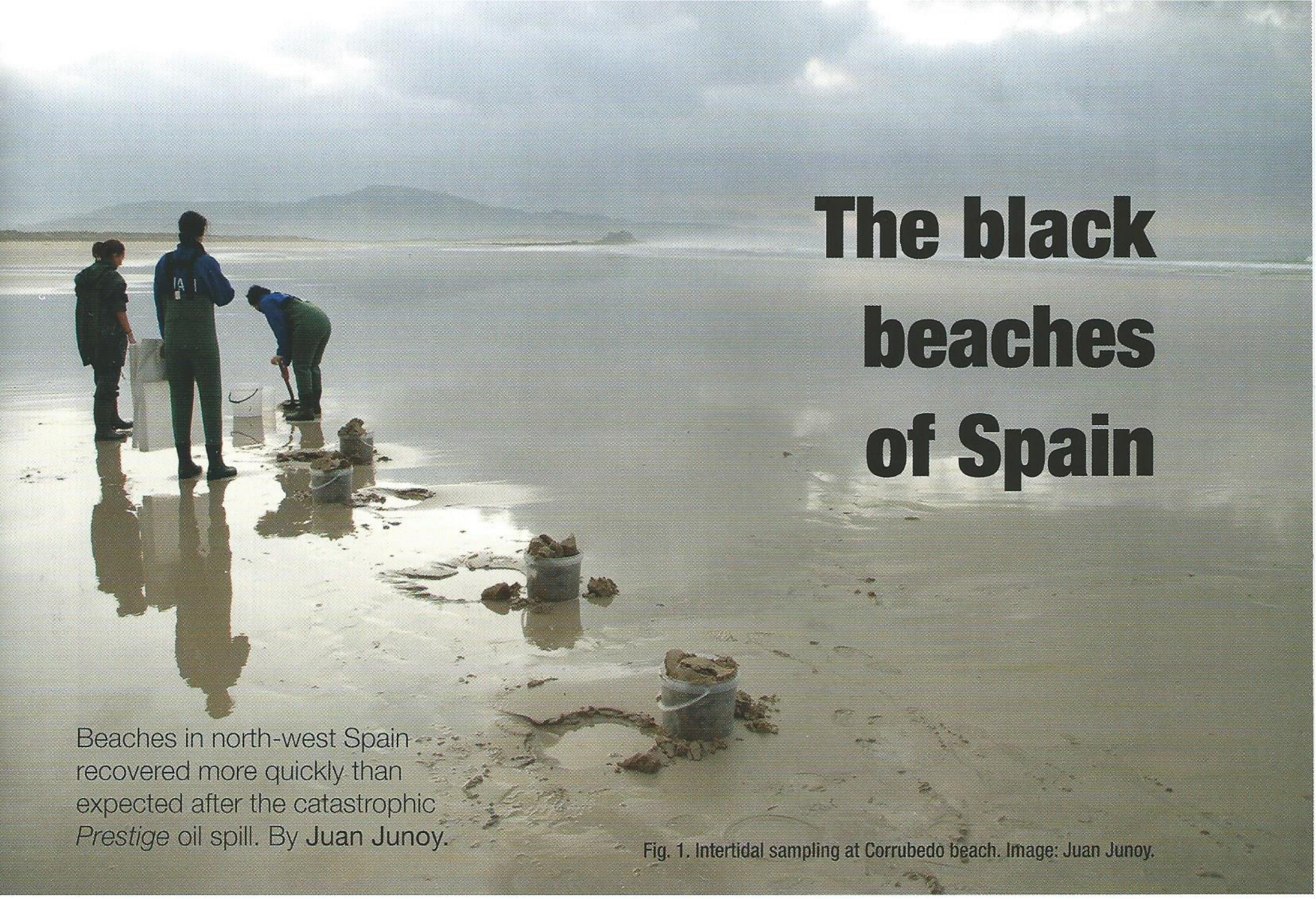

The black beaches of Spain

Beaches in north-west Spain recovered more quickly than expected after the catastrophic *Prestige* oil spill. By **Juan Junoy.**

Fig. 1. Intertidal sampling at Corrubedo beach. Image: Juan Junoy.

When Europeans think about their holidays, many of them have in mind the sunny beaches of the Mediterranean coast of Spain. Along this degraded littoral buildings have replaced dunes, and the border between the land and the sea is a continuous line of shops where you can buy typical Spanish crafts, most likely made in China, or Pacific seashells as Mediterranean souvenirs. The resort town extends to the dry sand where sun loungers, parasols and towels take over.

But Spain has some very different beaches on its less urbanized Atlantic coast. At these beaches, the tidal range is up to 4 m at spring tides. At low tide the beach has an extensive wet intertidal zone whereas the dry area, the supratidal zone, is usually relatively small (Figure 1). Waves can be very high; a record wave over 27 m in height was measured in January 2014 in Cape Vilán (Galicia, north-west Spain). Winter storms are frequent, and our story starts during one such storm on 13 November 2002.

On this day the *Prestige*, a tanker carrying 77,000 tonnes of heavy fuel oil, sent a SOS signal informing the Spanish coastguard that one of its tanks had burst off the coast of Galicia. Six days later, the ship split in half and sank, releasing the fuel oil into the sea. It was the start of the largest environmental disaster in the history of Spain. The black tide mainly affected Galicia's coast, but the oil also reached the French and Portuguese coasts.

The *Prestige* crisis also meant an opportunity for our research team, who had been investigating the macroinfauna (animals living within aquatic sediments and large enough to be seen with the naked eye) of the Galician beaches since 1982.

But surely, beaches are as barren as deserts? No! There are some invertebrate species adapted to live in these harsh, stressful habitats and you can collect them with an inexpensive methodology. Take the sand with a shovel, sieve it through a 1 mm mesh and dump the contents of the sieve into a tray with some water, then observe several small crustaceans swimming and some worms snaking. You can do this at different tidal levels of the beach and observe the biological zonation.

The dry sand of the upper beach belongs to the supratidal zone. The most characteristic aspect of this area is the dune flora, but our study was limited to the areas devoid of vegetation close to the deposit line where washed-up algae accumulate. This is a food source that is used for many air-breathing arthropods. Sandhoppers such as *Talitrus saltator* and *Talorchestia brito*, which evolved from fully-aquatic amphipods, emerge at night from their burrows. They are scavengers and eat almost anything containing organic matter. These species meet in the deposit line with fully terrestrial arthropods, such as the isopod *Tylos europaeus*, and insects (mainly dipterans and coleopterans).

The area that emerges as the tide retreats is the intertidal zone. This zone is inhabited by fully marine species, mainly

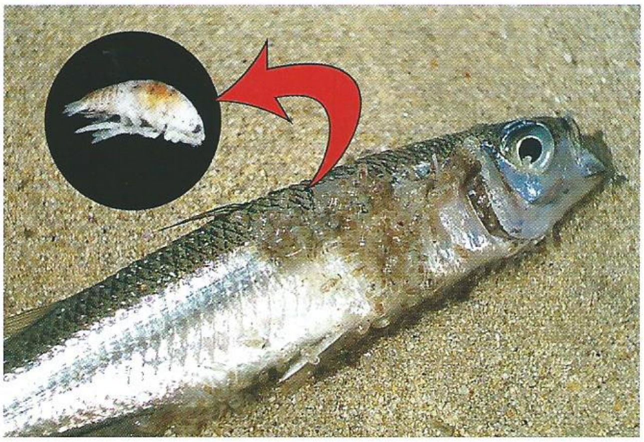

Fig. 2. The isopod *Eurydice* (inset) is a scavenger and predator. Here shown feeding on an injured fish. Image: Juan Junoy.

crustaceans and polychaete worms. Their distribution along the intertidal zone is related to both interstitial moisture levels in sand at low tide and to tide levels or inundation times. Three levels are distinguished: the upper level has damp sand (retention level); the middle level (resurgence level) where the phreatic (saturated) zone is found at less than 20 cm from the surface (the sand that has adequate water content to make sand castles); and the lower level where the phreatic zone is at the surface (saturation level). Macroinfaunal diversity and abundance increase from the upper to the lower level. The polychaete *Scolelepis squamata* lives in retention and resurgence levels; several species of the isopod genus *Eurydice* (see Figure 2), a scavenger/predator species that attacks injured fish, move actively leaving visible grooves in the resurgence and saturation levels. These two levels are also inhabited by the amphipods *Pontocrates arenarius* and *Haustorius arenarius*. The lower saturation level is also occupied by swimmers such as the mysids of the genus *Gastrosaccus* and cumaceans of the genus *Cumopsis*. At this level, we occasionally collected the only dangerous species of the beach, the lesser weever fish, *Echiichthys vipera*.

The beaches studied are all exposed environments, open to wave action, and even in calm weather, they are subjected to considerable swell. The fauna showed very low diversity and consisted largely of small crustaceans (which were numerically dominant) and, to a lesser extent, polychaetes. Severe exposure restricts diversity, reducing the presence of sedentary forms, especially bivalve molluscs, and encourages the numerical dominance of agile swimmers, such as amphipods and isopods. These macroinfaunal species are prey for fish and shorebirds.

The black tide of the *Prestige* oil spill affected cliffs and beaches, mainly those situated in the Galician province of A Coruña, along the 'Coast of Death', so named because of the many shipwrecks there. Beaches of the other two provinces (Pontevedra and Lugo), were less affected.

Our macroinfauna sampling started in May 2003, when most of the Galician beaches had already been cleaned (at least superficially; subsuperficial oil is frequently underestimated). During four consecutive years we studied 18 beaches along the 1,659 km of the Galician coast. Results were compared with previous data, mainly from 1995.

We observed a reduction in the number of species by beach only in the first year after the spill. There was also a negative relationship between the degree of pollution and species number, being lowest in the heavily polluted beach of O Rostro (see Figure 3), with only five species. Rare species occurring on beaches at low density were eliminated, and thus, species number was lower after the spill.

On all but two of the 18 beaches, the macroinfaunal abundance was also significantly reduced after the spill. The decrease in the abundance of the macroinfauna observed after the spill appears to reflect the losses due to oiling toxicity or indirect effects of oiling and clean-up. On seven beaches, the diversity was higher the first year after the spill, but there was not a statistically significant difference between before and one year after the spill, nor was there variation in the pollution grade among different beaches.

Four taxa were significantly reduced one year after the spill: the isopod *Eurydice*; the polychaete *Scolelepis squamata*; the nemertean *Psammamphiporus elongatus*; and the larvae of diptera. Sedentary species would provide the most reliable evidence of the effects of pollution. The abundance of *S. squamata*, a species without swimming activity and

Fig. 3. Samples from O Rostro beach showing oil pellets. Image: Juan Junoy.

Fig. 4. Cleanup activities on beaches affected by the spill. Image: Juan Junoy.

with general low mobility, seems to have been influenced by the spill, although it is likely that the beach cleaning which involved the removal of the sand was more important than the toxic effects of the fuel. One species that could be characterized as opportunistic, the amphipod *Pontocrates arenarius*, showed an increased abundance after the spill. This is quite surprising because substantial mortalities of amphipods were reported in other spills.

Interannual variations throughout the following three years of study (2004–2006) did not show strong differences in macroinfauna assemblage structure on the 18 beaches. We conclude that the *Prestige* oil spill affected the beach macroinfauna for the first 17–18 months.

When the black waves of oil arrived at the coast, the first impression among marine researchers—my own included—was that the catastrophe could affect the ecosystem for many years. Optimistic scientists thought that it would take about five years for the ecosystem to recover. Fortunately, the spill was not so environmentally apocalyptic; the result of our study shows rapid recuperation on the sandy beaches. This conclusion—a few years recovery—can also be extended to other elements of the Galician coast, with the notable exception of marine birds. However, experience shows that we cannot be confident that marine habitats will have an easy recovery after a spill. Each spill has its own characteristics including type of oil, geographical location, weather conditions, and how the cleanup operation is handled (Figure 4).

We must not forget that the *Prestige* oil spill also had strong economic and social impacts. I raise my voice and shout: '¡Nunca mais!' (Never again!).

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FURTHER READING

Junoy J., Castellanos C., Viéitez J.M., de la Huz M.R., Lastra M. 2005. The macroinfauna of the Galician sandy beaches (NW Spain) affected by the Prestige oil-spill. *Marine Pollution Bulletin*, 50: 526–536.

Junoy J., Castellanos C., Bernardo-Madrid R., Riera R., Viéitez J.M. 2014. Macroinfaunal recovery on the beach most severely affected by the 'Prestige' oil spill (O Rostro, Galicia, north-west Spain). *Journal of the Marine Biological Association of the United Kingdom*, 94 (1): 17–24.

McLachlan A., Brown. A.C. 2006. *The ecology of sandy shores*. Academic Press; 2nd edition.