

Kylie A. Pitt · Cathy H. Lucas
Editors

Jellyfish Blooms

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The idea for this book was conceived at the 2011 ASLO meeting in Puerto Rico when Martine van Bezooijen, a handling editor from Springer, approached us with the idea of producing a book about jellyfish blooms. Her idea followed from the great success of the four special volumes of *Hydrobiologia* resulting from the first three International Jellyfish Blooms symposia held in Alabama, USA (2000), Gold Coast, Australia (2007), and Mar del Plata, Argentina (2010) and the ASLO 2009 meeting in Nice. Martine was heavily involved in the production of several of these special volumes and was very keen to see a new book on the subject. A successful proposal was submitted to Springer and work on the book started in May 2011. Tragically, Martine passed away unexpectedly in early 2012 as a result of an accident. She was always very supportive of the jellyfish community and was regularly seen at the Springer stand at ASLO meetings. We would like to acknowledge her support and encouragement, as well as that of Judith Terpos who took over as handling editor of the book in mid-2012.

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Many of us have just returned from the 4th International Jellyfish Blooms Symposium held in Hiroshima, Japan, which was attended by 120 delegates from 28 countries. This represents a significant increase from the 60 or so delegates who attended the first two symposia. It was heartening to see so many Ph.D. students and early career researchers studying the science of jellyfish blooms. Recognition of both the scientific and socioeconomic importance of jellyfish blooms is clearly growing.

Finally, we would both like to acknowledge the support and encouragement provided by our families as we oversaw the production of the book.

Kylie A. Pitt
Cathy H. Lucas

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Chapter 10

Chrysaora plocamia: A Poorly Understood Jellyfish from South American Waters

Hermes Mianzan, Javier Quiñones, Sergio Palma, Agustin Schiariti,
E. Marcelo Acha, Kelly L. Robinson, and William M. Graham

Abstract Blooms and strandings of *Chrysaora plocamia* are reported to occur along both Atlantic and Pacific South American coasts. First described in Peruvian waters by Lesson (1830) almost two centuries ago as *Cyanea plocamia*, there is surprisingly little ecological information about this conspicuous animal. This chapter reviews current knowledge about *C. plocamia* biology and ecology, its relationship with pelagic fisheries and climate and the problems blooms cause in the Humboldt Current and Patagonian shelf ecosystems. *Chrysaora plocamia* has important ecological roles, including trophic and symbiotic interactions with fish and sea turtles. Population variability has a clear relationship with climate where phases of high *C. plocamia* biomass were associated with El Niño events occurring during warm “El Viejo” regimes. Interestingly, their estimated biomass occasionally approached those of sardines or anchovies. This large jellyfish negatively affects human industries in the region when abundant, including fisheries, aquaculture, desalination plants and tourism. Understanding relationships between jellyfish blooms and environmental drivers (e.g. ENSO, regime shifts) should allow forecasting of the jellyfish abundance and potential vulnerabilities such that resource managers and industrial fisheries owners may prepare for costly outbreaks.

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10.1 Introduction

J'admirai également de nombreuses méduses, et les plus belles du genre, les **Chrysaores**, particulières aux mers des Malouines [Malvinas Island]. Tantôt elles figuraient une ombrelle demi-sphérique très lisse, rayée de lignes d'un rouge brun et terminée par douze festons réguliers; tantôt c'était une corbeille renversée d'où s'échappaient gracieusement de larges feuilles et de longues ramilles rouges. Elles nageaient en agitant leurs quatre bras foliacés et laissaient pendre à la dérive leur opulente chevelure de tentacules.

[I also admired the numerous jellyfish, particularly the most beautiful of the genus, the Chrysaores, peculiar to Falkland/Malvinas seas. Sometimes they had a very smooth hemispherical umbrella, striped red-brown lines and completed by twelve regular festoons. Sometimes they became upside-down waste-paper baskets, from which grew gracious broad leaves and long red twigs. They swam waving their four leaf-like arms and let them hang drift their opulent hair tentacles.] – 20,000 Leagues Under the Sea, **Jules Verne**, 1869

Chrysaora plocamia (Cnidaria: Scyphozoa: Semaestomeae) is one of the largest and most conspicuous jellyfish found along the South American Pacific and Atlantic coasts (Fig. 10.1a–c). The bell diameter is typically 50–60 cm with the oral arms reaching lengths of 2–3 m. Rare specimens attain diameters of about 1 m with oral arms extending more than 3 m (Mianzan and Cornelius 1999). There is surprisingly little information about *C. plocamia* despite being first described almost two centuries ago in Peruvian waters by Lesson (1830) as *Cyanea plocamia*. This chapter reviews what is currently known about the biology and ecology of *C. plocamia*, its relationship with pelagic fisheries and climate and the problems *C. plocamia* blooms can cause. Our synthesis is derived from a variety of bibliographic sources, including technical reports, anecdotes and other non-peer-reviewed resources not typically available to the international scientific community.

Chrysaora plocamia can be found across a range that encompasses two major Large Marine Ecosystems (LMEs): the Humboldt Large Marine Ecosystem in the Pacific and the Patagonian Shelf Large Marine Ecosystem in the Atlantic (Heileman 2009; Heileman et al. 2009). These LMEs, with a combined coastline of 13,000 km and surface area of more than 5.5 million km², represent a large fraction of South American coastal waters (Miloslavich et al. 2011). High biological productivity here contributes to about 15 % of global fish landings. In the Humboldt LME, *C. plocamia* ranges from Peruvian to Chilean waters. The species is far more concentrated in these northern waters compared to southern Chilean waters (Fig. 10.2). *C. plocamia* in southern waters was reported as *Chrysaora* sp. (Vanhöffen 1888) in the Magellan Strait, as *C. hysoscella* by Vannucci and Tundisi (1962) around the Antarctic Peninsula and as *C. plocamia* in the Beagle Channel (Mianzan and Cornelius 1999), but all these populations have since been recognised as *C. plocamia* (Morandini

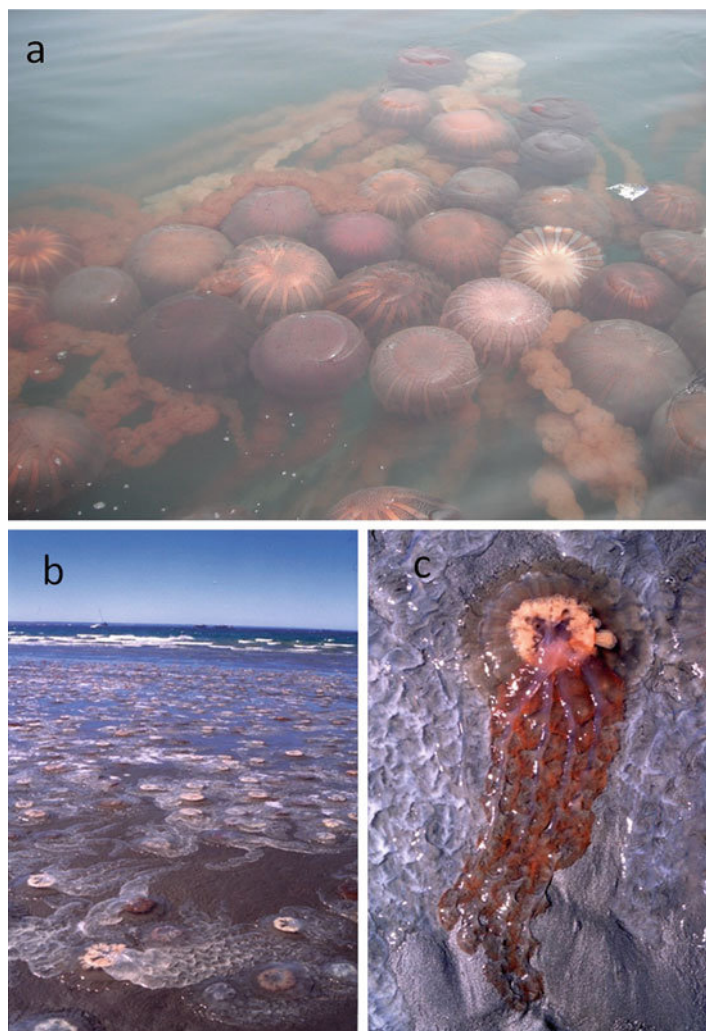


Fig. 10.1 (a–c) (a) Bloom of *Chrysaora plocamia*, May 2012 off Callao (12°04'S), Peru (Photo by Mario Rosina). (b) Stranding event of *Chrysaora plocamia* at Puerto Madryn, Chubut, Argentina. (c) Detail of a pigmented specimen (Photos by José Luis Esteves)

and Marques 2010). The species is also common in Atlantic waters (Mianzan and Cornelius 1999; Morandini and Marques 2010), where large conspicuous blooms occur with some regularity along the northern Patagonian coast becoming rare northerly (Mianzan and Cornelius 1999; Mianzan et al. 2005). The connectivity of *C. plocamia* between the Pacific and Atlantic oceans is likely facilitated by circulation within the Patagonian cold estuarine zone (Acha et al. 2004).

As with most coastal jellyfish species from temperate waters, *C. plocamia* exhibits strong seasonality. Although information about *C. plocamia*'s reproduction is

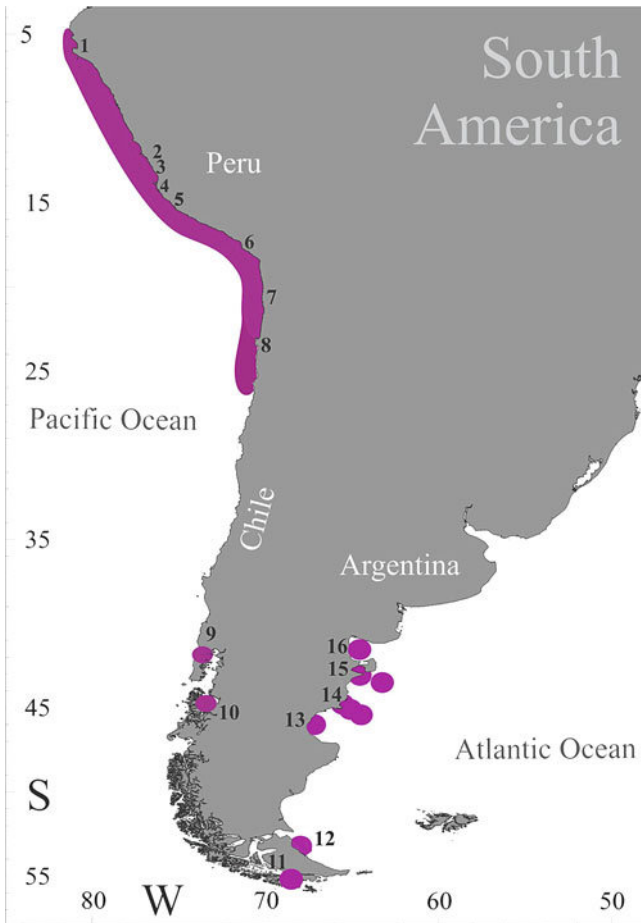


Fig. 10.2 Distribution of *Chrysaora plocamia* in South America. Humboldt Large Marine Ecosystem, **Peru**: 1 Bahía Sechura, 2 Callao, 3 Pisco, 4 Paracas, 5 Bahía Independencia, 6 Ilo; **Chile**: 7 Arica, 8 Antofagasta, 9 Isla Chiloé, 10 Aysén region; Patagonian Shelf Large Marine Ecosystem, **Argentina**: 11 Canal de Beagle, 12 Bahía San Sebastián, 13 Golfo San Jorge, 14 Cabo Dos Bahías, 15 Golfo Nuevo, 16 Golfo San Matías. Shaded and dotted areas indicate the known distribution of *C. plocamia*

still pending, polyps, strobilae, ephyrae and juvenile medusae were recently reared in the laboratory from planulae collected from mature specimens (Morandini pers. comm.). Post-ephyrae and juvenile stages occur during early austral spring, while adult medusae are common during austral summer–autumn (Mianzan 1986, 1989; Quiñones 2010). Medusae then senesce, losing tentacles and oral arms, and sink to the seabed in late autumn–early winter (Fig. 10.3). Abundance is lowest during winter; however, overwintering medusae are observed. Ephyrae frequently found in Chilean fjords during spring are probably those of *C. plocamia* (Bravo et al. 2011; Palma et al. 2011).



Fig. 10.3 Senescent *Chrysaora plocamia* on the sea floor close to Caleta Olivia, Santa Cruz, Argentina (Photo by José Adrián Acosta Fabio)

Coloration patterns of medusae differ by region from being totally transparent to being whitish with a few irregularly distributed brown-reddish spots to being completely yellow, red or brown with 16 triangular streaks radially distributed on the bell (see Mianzan and Cornelius 1999; Morandini and Marques 2010). Most Peruvian specimens have dark and highly varied coloration. Medusae from southern Chile and Argentina are typically lighter, with only few specimens intensely pigmented (Fig. 10.1a–c). Observations of juveniles and even ephyrae in different and separate areas may suggest the existence of local populations. *Chrysaora plocamia* was found to be morphologically identical to *C. achlyos* (Morandini and Marques 2010), and genetic analysis is still needed to establish if differences in distribution reflect separate species (Morandini and Marques 2010, Dawson and Gomez Daglio 2012 pers. comm.).

10.2 Blooms of *Chrysaora plocamia*: Relationship with Climate

Climate is understood to be a main driver of biological productivity in upwelling systems. The Humboldt Current ecosystem is known to respond to climate, including the El Niño Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) (Bakun 1996; Chavez et al. 2003, 2008). As an example, populations of the

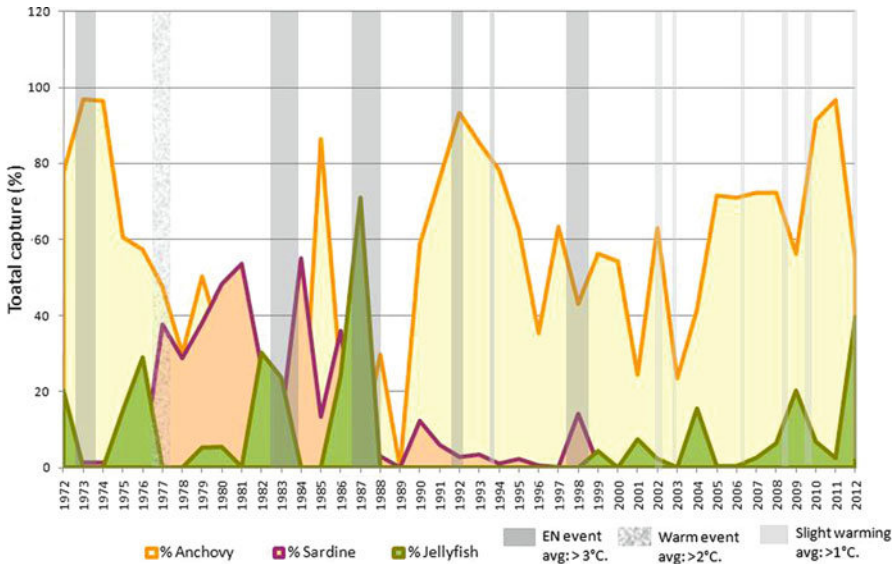


Fig. 10.4 A 40-year time series (1972–2012) of pelagic fishing landings (% wet weight) of anchovy (*Engraulis ringens*), sardine (*Sardinops sagax*) and jellyfish (*Chrysaora plocamia*) from Peru. Shaded areas represent ENSO and warm years. Bar width indicates the duration of the warm event (in months). The series represent the effort of 11,702 fishing hauls carried out annually during spring–autumn

Peruvian anchovy (*Engraulis ringens*) and sardines (*Sardinops sagax*) undergo interannual and interdecadal fluctuations in response to ENSO (El Niño–La Niña) and the PDO (El Viejo–La Vieja), respectively (e.g. Bakun 1996; Chavez et al. 2003, 2008; Fréon et al. 2008). Strong El Niño or La Niña events have large cascading ecosystem effects. Among these are changes to reproductive strategies of fish and, ultimately, changes to fisheries yields (e.g. Arntz and Valdivia 1985).

Similar climate-driven variability occurs in jellyfish populations (Brodeur et al. 2008; Suchman et al. 2012; Robinson and Graham 2013). *Chrysaora plocamia* biomass varies with ENSO (Quiñones 2010; Quiñones et al. 2010, 2013) as jellyfish biomass is usually high the year immediately preceding and during El Niño events. A long-term data set of jellyfish biomass taken during Peruvian research cruises from 1972 to 2012 indicates that population size fluctuated on annual to decadal scales. The consistency of this pattern during those decades led to this species being proposed as a potential indicator of El Niño phases in Chile (Alvial et al. 1984; Soto 1985). However, low medusa biomass from 1989 to 2009 in spite of several El Niño events occurring during these years suggests that other factors were also influencing its abundance. Variations in *C. plocamia* biomass were strongly matched to interdecadal phases known as “El Viejo” (a warm phase) and “La Vieja” (a cold one). The contribution of *Chrysaora plocamia* to the total pelagic catch was particularly high (20–70 % wet weight) when El Niño occurred during the warm “El Viejo” regime from the mid-1970s to 1980s (Fig. 10.4).

Decades with high medusa biomass coincided with a warm, “sardine-dominated” regime that began in 1975 and continued until the mid-1990s. Conversely, low abundances of medusae occurred during the cool “La Vieja”, anchovy-dominated regime that followed (Fig. 10.4; Chavez et al. 2003, 2008). *Chrysaora plocamia* began to increase in 2007, reaching 40 % of the total pelagic catch in 2012, concomitant with a modest but increasing sardine capture by the artisanal purse seine fishery, suggesting the Humboldt Current ecosystem had undergone a shift once again to a warm, “El Viejo” regime.

10.3 Ecological Interactions of *Chrysaora plocamia* in the Pelagic Realm

Chrysaora plocamia is an important member of the Humboldt and Patagonian Shelf LMEs given its ability to dominate the pelagic biomass. Jellyfish in general consume a wide selection of zooplankton and in large quantities (see Arai 1988), so *C. plocamia* quite possibly exerts strong, top-down ecological forcing when abundant.

Scientific observations of fishes feeding on *C. plocamia* are scarce in both the Humboldt Current and Patagonia shelf ecosystems. However, there are anecdotal suggestions that fish prey on *C. plocamia*. Artisanal fishermen from Bahía Independencia (Peru) used “gonads” of *C. plocamia* as bait to catch the Centrolophid palm ruff (*Seriotelella violacea*). This practice makes sense considering *Seriotelella violacea* have been shown to eat large quantities of jellyfish including salps, pyrosomes and ctenophores (mainly *Mnemiopsis leidyi*) (e.g. Arai 1988; Mianzan et al. 1996, www.fishbase.org). Recently, large juveniles of *S. violacea* were observed biting the medusae and mesoglea was occasionally found in their stomachs (Riascos et al. 2012a).

Chrysaora plocamia also form part of the diet of some sea turtle species; however, turtles need to consume large volumes of gelatinous prey to meet their nutritional requirements (Hays et al. 2009). Three of the five turtle species reported for Peruvian waters feed specifically (leatherback turtle, *Dermochelys coriacea*) or at least opportunistically (green turtle, *Chelonia mydas agassizii*, and olive ridley, *Lepidochelys olivacea*) on medusae (Quiñones et al. 2010; Goya et al. 2011). *Chrysaora plocamia* biomass appears to be sufficient, particularly during ENSO years, to support *C. m. agassizii* (Quiñones et al. 2010).

Jellyfish like *C. plocamia* provide structure that favour many types of ecological interactions in the pelagic realm; they may be used as a source of shelter and food or a focus for aggregation (e.g. Arai 1997; Towanda and Thuesen 2006). Their large bell and conspicuous oral arms may provide shelter and food for schools of juvenile stages of the starry butterfish (*Stromateus stellatus*) (Elliot et al. 1999) and other stromateid juvenile fish in the Patagonian shelf ecosystem (Mianzan pers. obs., A. Gosztonyi 2012 pers. comm.) (Fig. 10.5). Large scyphomedusae in particular often harbour juvenile or small adult fish under the bell or among the

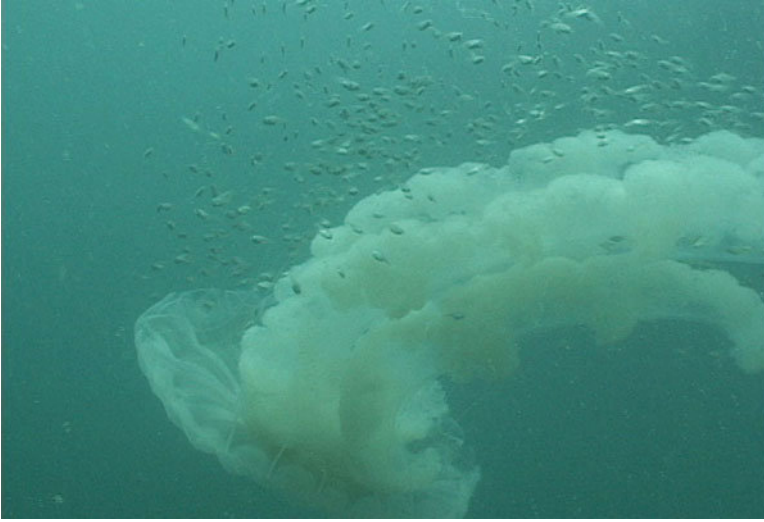


Fig. 10.5 *Chrysaora plocamia* accompanied by a school of stromateid juvenile fish off Puerto Madryn, Chubut, Argentina (Photo by J. Costello)

tentacles and oral arms. These fishes probably find shelter and protection from larger predators and may also benefit from prey stung and caught by the jellyfish (Purcell and Arai 2001).

Numerous invertebrate taxa utilise *C. plocamia* for substrate within the structureless water column. The hyperiid amphipod *Hyperia curticephala* has been described associating with *C. plocamia* medusae in coastal waters of Paita and Mejillones Bays (northern Peru and northern Chile, respectively) (Oliva et al. 2010). The authors reported one of the highest numbers of amphipods per medusa available in literature. Associations between hyperiid amphipods and medusae are widely documented (e.g. Laval 1980; Arai 1997; Towanda and Thuesen 2006, see also Chaps. 4 & 5). These associations are complex and vary greatly in timing, degree of dependence of the hyperiids on their hosts for shelter or for food and extent of maternal care (Gasca and Haddock 2004). The presence of small portions of mesoglea in the gut contents of all amphipods dissected suggests that *H. curticephala* uses *C. plocamia* not only as substrate in the pelagic realm but also as a food source (Oliva et al. 2010). Oliva et al. (2010) considered this association as micro-predation. Predation of hyperiids on medusae suggests that an equilibrium exists between its feeding rate and the regeneration rate of medusa tissue (Laval 1980). It was also proposed that amphipods may constitute a prey item for juveniles of *S. violacea* feeding on them and channelling energy back to fishes. The association between another invertebrate, the parasitic anemone *Peachia chilensis*, and *C. plocamia* as a host has been recently described. The parasite induced castration, reduction of fecundity and host mortality (Riascos et al. 2012a, b).

Table 10.1 Socio-economic impacts of mass occurrences of *Chrysaora plocamia* around South America

Industry	Event	Location	Source
Fisheries	Jellyfish by-catch in Peruvian artisanal fisheries	Pisco, Peru	Dr. Valdivia IMARPE pers. comm.
	Jellyfish by-catch in Peruvian industrial fisheries	Ilo, Peru	Quiñones et al. (2013)
Water inlets	Jellyfish clogging seawater intakes of floating pump stations	Callao, Peru	Federico Iriarte (2012) pers. comm.
	Desalination plant blocked	Antofagasta, Chile	Aldo Pacheco (2012) pers. comm.
	Clogging of ships' seawater intakes	Golfo Nuevo, Argentina	Mianzan (1986, 1989), Mianzan et al. (2005), Ricardo Vera (2012) pers. comm.
Aquaculture	Affected salmon aquaculture facilities	Chiloé, Chile	Palma et al. (2007), Bravo et al. (2011)
Tourism	Mass strandings	Golfo Nuevo, Argentina	Mianzan et al. (2005)
	Mass strandings, stinging	Paracas, Peru	Vera et al. (2004, 2005)
	Mass strandings, stinging	Arica, Iquique and Antofagasta, Chile	Vera et al. (2004, 2005), Vega and Ogalde (2008)

10.4 Economic Impact of *Chrysaora plocamia* Blooms: Is It a Troublesome Species?

There is a growing body of information suggesting *Chrysaora plocamia* is a nuisance for several human industries in South American waters (Table 10.1), which is not surprising given economic losses caused by other jellyfish species elsewhere (Nagata et al. 2009; Purcell 2012). Tourism, fishing, aquaculture and energy production are among the industries most affected by jellyfish (e.g. Chap. 6, Möller 1984; Verner 1984; Mianzan 1986, 1989; Williamson et al. 1996; Uye and Ueta 2004; Uye 2008), and species from the genus *Chrysaora* are sometimes cited as being problematic. For example, it has been suggested that *Chrysaora fulgida* has replaced fishes and has been inhibiting the recovery of sardine stocks in Namibian waters (Lynam et al. 2006; Flynn et al. 2012).

10.4.1 Fisheries

Jellyfish generally cause problems to fishing operations when abundant, and clogging of gear is the most reported effect (e.g. Purcell et al. 2007; Dong et al. 2010). Clogged gear can cause a wide spectrum of issues ranging from increases in fishing effort and

gear damage to injuries to fishers and fishery closures that result in severe income loss (e.g. Möller 1984; Graham et al. 2003; Kawahara et al. 2006; Purcell et al. 2007).

Fisheries landings in Peru, Chile and Argentina may represent about 15 % of the world's total marine landings (Official Statistics from each country see Vice Ministry of Fisheries, Peru; National Service of Fisheries, Chile and Ministry of Agriculture, Livestock and Fisheries, Argentina). These fisheries represent nearly 11 million tonnes annually, and the biological productivity supporting these fisheries also supports the production of jellyfish.

The by-catch of *C. plocamia* in Peruvian waters generates economic losses mainly to artisanal and commercial purse seine fisheries. Interference is particularly problematic during warm phases of ENSO when *C. plocamia* are so numerous (Fig. 10.6a, b) that fishers had trouble finding waters without jellyfish to operate the gear (Dr. Valdivia, Instituto del Mar del Perú (IMARPE), pers. comm.). These fishing operations are substantial, involving 1,700 vessels each with a hold capacity from <30 to 900 tonnes (Fréon et al. 2008; Alfaro-Shigueto et al. 2010).

Within the artisanal fleet, jellyfish must be removed manually; however, total removal is difficult to achieve at sea (Fig. 10.6b). Thus, jellyfish are manually unloaded with the fish catch and discarded in port. Information from IMARPE fisheries observers from the Pisco area indicated that jellyfish by-catch averaged 10 % annually in 2007, 2008 and 2009. This percentage increases to 20–40 % of the total catch during summer when *C. plocamia* biomass tends to reach its annual peak.

The commercial purse seine fishery operates differently to the artisanal one. Both fish and jellyfish are removed directly from the purse seine net by suction and held within the ship without sorting and discarding jellyfish. These result in a large displacement of fish catch by jellyfish and also result in loss of revenue or even the total catch being rejected by processing plants. *Chrysaora plocamia* by-catch in the southernmost Peruvian fishing harbour of Ilo was enough to cause losses exceeding \$200,000 (USD) in 35 summer days (Fig. 10.6c). Fishery factories refused to receive the catch if jellyfish by-catch was greater than 40 % of total weight (Quiñones et al. 2013). Thus, economic losses to both artisanal and commercial fishing have the potential to become substantially high during warm periods like El Niño when *C. plocamia* tend to be more abundant.

10.4.2 Aquaculture

General information about effects of jellyfish on fish aquaculture is limited to relatively few well-documented incidents (Purcell et al. 2007; Doyle et al. 2008; Baxter et al. 2011). There is evidence *C. plocamia* has interfered with salmon aquaculture operations in Chile (southern Humboldt Current). Since 1980, salmon farming in Chile has grown from 10,000 tonnes in 1988 to 470,000 tonnes in 2009 (Soto et al. 2001; Palma et al. 2007; SERNAPESCA 2012).

From February to June 2002, salmon aquaculture facilities were affected by proliferations of *Chrysaora plocamia* (Fig. 10.7a). It is likely that *C. plocamia* caused

Fig. 10.6 (a–c) (a) Capture of *Chrysaora plocamia* by the Peruvian Research Vessel “José Olaya Balandra” off Peru in summer 2009; (b) by-catch of *C. plocamia* by an artisanal purse seine vessel during an anchovy (*Engraulis ringens*) fishing operation off Callao, Peru (Photo by Yuri Hooker); (c) anchovy landing of an industrial purse seine vessel with >70 % by-catch of *C. plocamia* in the port of Ilo (Peru—January 2009). The whole catch was discarded

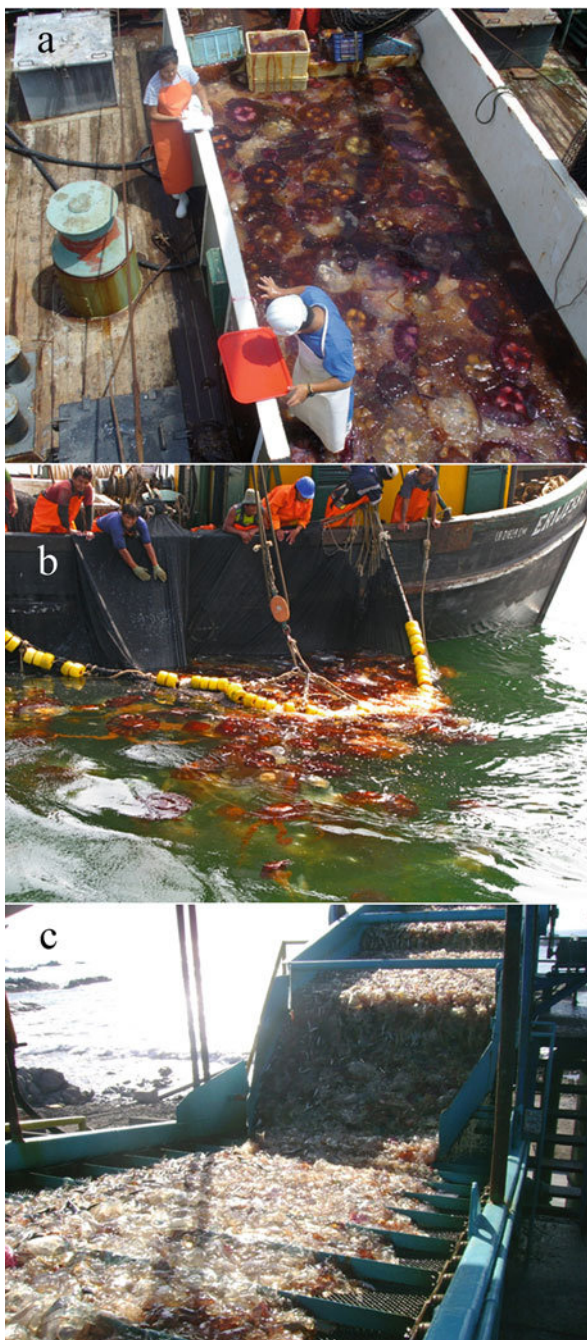
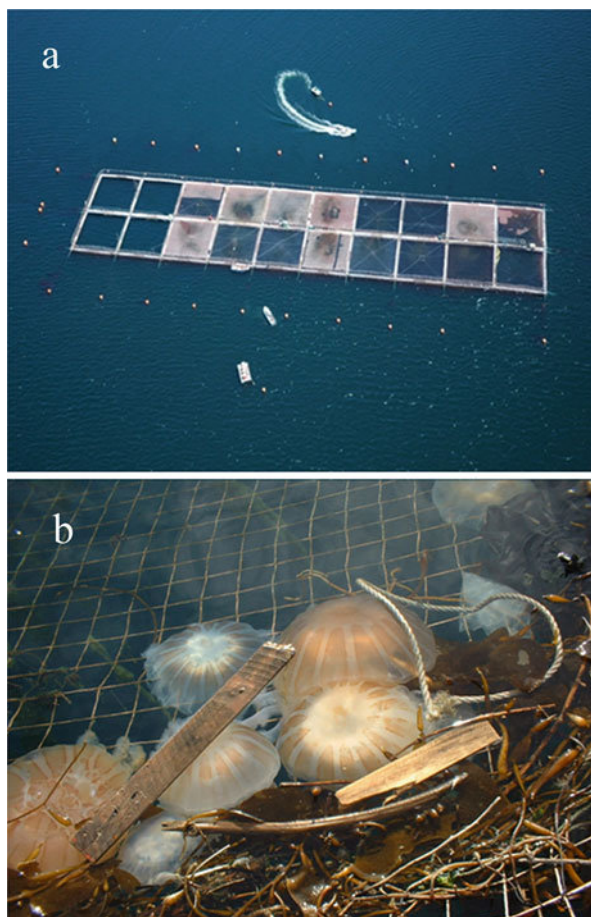


Fig. 10.7 (a–b) (a) Aerial view of salmon farming facilities surrounded by *Chrysaora plocamia* (Chiloe Island, southern Chile). (b) Detailed view of broken *C. plocamia* on nets of floating salmon culture cages in Chiloe, Chile



fish mortality by damaging the gill tissue resulting in suffocation (Palma et al. 2007). Medusae become pressed against the nets and their tissues split into several, smaller pieces that passed through the mesh of the floating cages (Fig. 10.7b). It was also proposed that fish were unable to feed inside the floating cages during such events (Bravo et al. 2011) and many died due to stress and starvation. Fish natural mortality doubled during this event and more than 60 % of the dead fishes presented eye injuries (blindness).

10.4.3 Clogging of Cooling Water Intakes

Chrysaora plocamia medusae have been responsible for clogging water intake systems of ships and shore-based facilities. When abundant, this species has caused significant problems in Argentinean and Peruvian harbours (Schweigger 1959 cited in

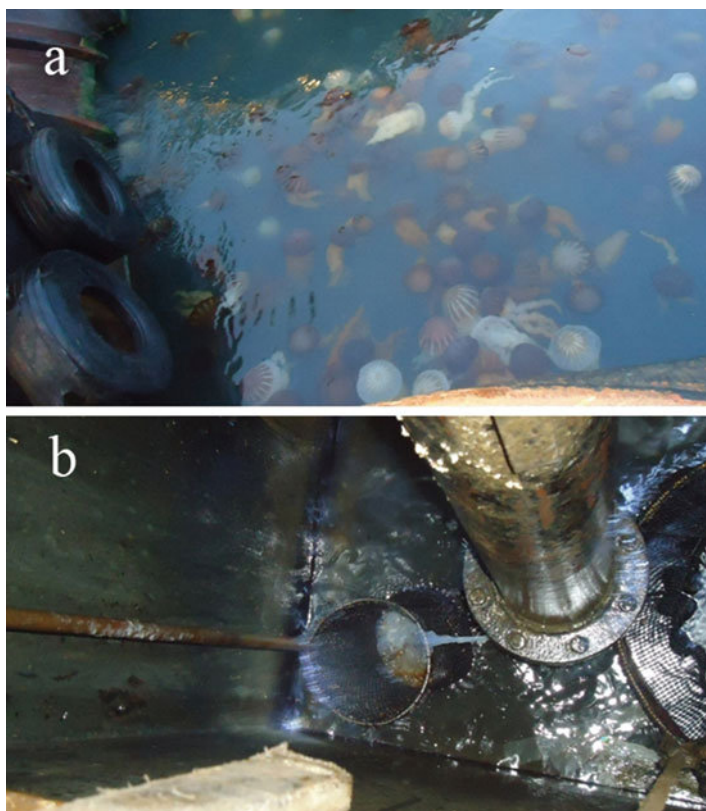


Fig. 10.8 (a–b) (a) Cooling water intakes clogged by *Chrysaora plocamia* in floating structures for industrial fishery landings in Callao harbour Peru (June 2012). (b) Manual removal of jellyfish remains from ship pumps

Möller 1984; Mianzan 1989). During the summer of 1999–2000, the water intake systems of ships anchored in the harbour experienced clogging when a massive stranding of *C. plocamia* occurred in Nuevo Gulf (Mianzan et al. 2005) and it required several hours for divers to clear the jellyfish from the system (Ricardo “Bebote” Vera 2012 pers. comm.). In another example from El Callao harbour, Peru, in early 2012, several vessels experienced clogging while transferring fish to factories on land. Here, seawater intakes of floating pump stations called “chatas” that supply water for the operation were blocked. Blockage due to medusae during the bloom resulted in delays and stoppages before jellyfish were manually removed (Fig. 10.8a, b).

Chrysaora plocamia blooms also affected a desalination plant in Chile. The city of Antofagasta is in the middle of Atacama Desert located in northern Chile, where 70 % of the freshwater is supplied by a desalination plant. The water intake pipes are often blocked by *C. plocamia* during summer. Reduced production resulted in social disturbances and economic losses (Aldo Pacheco 2012 pers. comm.).

Fig. 10.9 Skin reactions shortly after *C. plocamia* stings



10.4.4 Tourism

Tourism impacts by jellyfish are widely recognised in tropical and subtropical regions of North America, Europe and Australia, but only a few cases are known from South America. Large numbers of *C. plocamia* or their remains have caused problems in tourist areas of Paracas in Perú; Arica, Iquique and Antofagasta in Chile; and Puerto Madryn in Argentina. Strandings tend to happen in late spring–summer (Vera et al. 2004, 2005) and are especially large during El Niño events in Peru and Chile. Aquatic sports like kayaking, rowing, wake boarding, diving, swimming and sailing are frequent in the area where the jellyfish were aggregated; consequently, *C. plocamia* was responsible for one of the most frequent causes of skin irritations in swimmers (Vera et al. 2005). The mildly toxic venom of *C. plocamia* can cause slight cutaneous and ophthalmologic manifestations within the first 24 h. Delayed long-term reactions in individuals who have been sensitised through previous contacts can result in an immune response such as skin lichenification (Vera et al. 2004, 2005; Vega and Ogalde 2008) (Fig. 10.9).

10.5 Concluding Remarks

Chrysaora plocamia is very large and colourful and therefore a quite conspicuous animal that is difficult to overlook. The species is an important member of the coastal marine ecosystems of South America having important ecological roles, including trophic and symbiotic interactions with fish and sea turtles. Population variability has a clear relationship with climate where phases of high *C. plocamia* biomass were associated with El Niño events that occurred during “El Viejo” warm regime. Interestingly, biomass occasionally approaches sardines or anchovies stock

biomass estimates. This large jellyfish negatively affects human industries in the region when abundant, including fisheries, aquaculture, desalination plants and tourism. Understanding relationships between jellyfish blooms and environmental drivers (e.g. ENSO, regime shifts) should allow forecasting of the jellyfish abundance and potential vulnerabilities such that resource managers and industrial fisheries owners may prepare for costly outbreaks.

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