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Biodiversity in the era of the market globalization: some cases from the marine realm

Marco Arculeo

Dipartimento STEBICEF, Via Archirafi 18, 90123 Palermo, Italy; e-mail: marco.arculeo@unipa.it

ABSTRACT The globalization of markets and te growing scarcity of te mediterranea fishery products caused by the over-exploitation of the most consumed species has determined an increase in demand of frozen or trasformed fishery products importated from different countries. This caused an increase of food fraud represented by the substitution of a species with another with less economical value but which presents similar morphological characeristics. The use of modern tools as the DNA barcoding is crucial for traceability of such products and provides the consumer the necessary information about the exact identification of the species and their origin. The Italia and European Union food stuff are controlled thanks to laws, while for many non UE products are not expected any control inspection.

KEY WORDS DNA barcoding; food fraud; marine species; free markets.

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INTRODUCTION

In recent years, biologists have been involved in studying the changes of the marine biodiversity taking into account the global climate change and the advanced tropicalization of the Mediterranean Sea. Particular attention has been paid to the Indo-Pacific species that due to the opening of the Suez Canal have increasingly colonised Mediterranean waters and, for some of these, now can be considered as "established", in the sense of CIESM Atlas series (2002, 2004) or "invasive"sensu Zenetos et al. (2010); in addition it has also been registered an increase of thermophilic species of Atlantic origin (Golani et al., 2002; Galil et al., 2002; Zenetos et al., 2004). These changes, however, did not take into account how the natural diversity has, in some way, influenced also the diversity of the Italian fish markets in terms of availability or supply of new species that came from other parts of the world.

In the European Union, the Regulation (EC) 854/04 refers to the official control of foodstuffs and highlights how the controls are also to be based on the inspection of these products. Any inspections to be carried out on the fish or fishery products presuppose the correct identification of the species to which they belong. The food fraud, for example, is represented by the substitution of a food with another with less economical value but which presents similar macroscopic morphological characteristics that can easily mislead the buyer. This fraud can occur through the use of names and trademarks of local products or trademarks of some companies. These substitutions are carried out with the purpose of making a profit, and occur when the seller trust on consumers ignorance due to their inability to properly identify the product they are interested in.

The morphological identification of invertebrate and vertebrate marine species of commercial

interest (crustaceans, molluscs, fish) in some cases can be difficult especially when these products are marketed or sold already portioned or in the form of pulp (crabs) or cut into small pieces or slices (squid, cuttlefish, octopus, fish, etc.) or without shell or carapace (decapod crustaceans, molluscs bivalves or gastropods). The classical approaches of identification are not useful in many cases because during the processing, most of the morphological characteristics of the product are often lost, making it difficult to identify.

The globalization of markets and the growing scarcity of the Mediterranean fishery products caused by the over-exploitation of the most consumed species (Tsikliras et al., 2015), determined an increase in demand and a higher exchange capacity of fishery products, especially in those countries where requests for frozen or transformed products are still rising. The use of modern tools for the traceability of such products on one side provides the consumer with the necessary information enabling him to know the "history" of the food and on the other give the authorities a valuable support in case of food emergency or in the identification of food fraud.

For these reasons it is essential to find appropriate and easy technologies that increase food security and enable it to monitor effectively the food fraud and illegal trade of organisms potentially dangerous to human health, or rare and threatened species.

One of the most commonly used techniques for its low costs and the effectiveness of the produced results is the DNA barcoding. This technique was proposed for the first time by Hebert et al. (2003) as universal tool for the Barcoding of Life; it is a simple method that use, as marker, a fragment of about 655-bp of the 5' region of the mitochondrial cytochrome c oxidase I (COI) gene. To date, few studies are available on the application of this technique that allows us to have good results both as a support to the classical taxonomy and as a tools of food control. This is unfortunate, as recognition of genetic fishery products through the DNA barcoding provides a reliable and safe identification system.

While for some groups of organisms, such as fish, there is a database of reference (Landi et al., 2014; and references therein), in the case of other groups as invertebrate the available databases of sequences has to be improved.

The aim of this report is to highlight some critical issues that can be encountered at the Italian "free fish market" (single shop outside the supermarket, then referred to the small distribution of fish products) where normally fishmonger uses a simple label where only the local or the Italian name of the species is reported. Conversely, according to the European Union Regulation (EC) 854/04, the buyers should find in all the products a label where is reported the name of species (both the latin name and the Italian vernacular one), tool used for the capture, area FAO of origin/catch, possible conservation treatments, etc... This means that the "free fish market" does not currently comply with the law and that the fish seller may sell all he/she wants without any control. In fact, most of the food fraud and/or substitutions of species occurred mainly in the free fish markets. Although supermarkets show complete labels they can not give to the consumer, unless they certify them through their own laboratories, a 100% guarantee of products declared.

CRUSTACEANS

Referring to some examples, there are groups of crustaceans with high economic value that can be subject to fraud through the exchange with other economically less-valuable species. This is the case of the European spiny lobster *Palinurus elephas* Fabricius, 1787 (Decapoda Palinuridae) a coastal species that lives on rocky and coralligenous substrates that can be replaced with the pink spiny lobster *Palinurus mauritanicus* Gruvel, 1911 a deeper-living species that inhabits the edge of the continental shelf. Most of the quantities of this species that are found on the Italian free fish markets comes from the Atlantic Ocean. *Palinurus elephas* has, in the European free fish markets and supermarkets, a price which is higher than that of *P. mauritanicus* and can be easily confused by consumers with this last. Recently, appears in the supermarkets another species of lobster, *P. regius* De Brito Capello, 1864 that may be also confused with *P. elephas*. *Panulirus regius* is an Atlantic thermophilic species that has first colonised the northwestern Mediterranean along the coasts of France and Spain and which recently seems to have shifted towards the Italian coasts even if catches remain extremely low (Froglia et al., 2012). All these lobsters

species are generally sold without carapace and with a label indicating generically "lobsters".

A more serius problem is when the free fish markets trying to sell the species *Polycheles typhlops* C. Heller, 1862 (Decapoda Polychelidae), a species without commercial value, as "minor lobster". This Polychelidae is sold some times under the generic Italian name of "aragostella" (i.e.: "little lobster") indicating a species similar to the lobster but with a lower economic value. More frequently, and more correctly, free fish markets indicated with the generic name of "aragostella"the Indo-Pacific species *Puerulus* spp. (Decapoda Palinuridae). They genus comprise about 10 species and are sold also in the supermarkets in plastic box and with a label indicating only the name of the genus *Puerulus* Ortmann, 1897, and the origin of catch.

Other case concerns *Homarus americanus* H. Milne-Edwards, 1837 (Decapoda Nephropidae), American lobster, species imported mainly from the USA and sold instead of *Homarus gammarus* Linnaeus, 1758, European lobster, a Mediterranean species; this substitution is widespread especially in restaurants as well as in the free fish markets.

Recently, appeared in the fridges of the supermarkets an Indo-Pacific crustacean species sold with a label indicating the italian name "mazzancolla" and the scientific name *Penaeus vannamei* (Boone, 1931) (Decapoda Penaeidae). This species in nature has a more or less greyish colour, but it is sold cooked because after cooking it assumes a orange colour, which looks more pleasing to the eyes of the consumer. In Italy, usually, the name "mazzancolla" is used to indicate another crustacean species, *Melicertus kerathurus*, with a very high economical value. *Melicertus kerathurus* (Forskål, 1775) is another crustacean case of possible replacement with the very similar species *Marsupenaeus japonicus* (Spence Bate, 1888), a Lessepsian species very invasive which replaced, in the eastern sector of the Mediterranean Sea, the endemic species *M. kerathurus*. Today, *M. japonicus* can be considered in Mediterranean Sea as an established species (Zenotos et al., 2010).

Another possible replacement or fraud is between the *Aristaeopsis edwardsiana* (Johnson, 1868) (Decapoda Aristeidae), an Atlantic species which is not present in the Mediterranean and is imported and sold as defrosted product, and the giant red shrimp *Aristeomorpha foliacea* (Risso, 1897), the commercially most important deep-water shrimp in the Mediterranean Sea. The two species might be easily confused by consumers when buying them in the free fish markets.

The last new entry in the free fish market and supermarkets refers to the *Pleoticus muelleri* (Bate, 1888) (Decapoda Penaidae), a very abundant species along the coasts of Argentine, which is sold as defrosted or "fresh" pink shrimp. This specie is sold defrosted in the free fish market as the Mediterranean deep-water rose shrimp *Parapenaeus longirostris* Lucas, 1847 a species with higher economic value.

MOLLUSCS

As regards molluscs, cases of food fraud are mainly linked to the commercialization of *Ruditapes phylippinarum* (Adams et Reeve, 1850) (Bivalvia Veneridae) a clam species native of the Pacific Ocean introduced in the Mediterranean Sea (Adriatic Sea) for commercial purposes in the 80s and that now can be considered as an established species (Zenetos et al., 2010). This species is confused with the endemic (Mediterranean) bivalve *Ruditapes decussatus* (Linnaeus, 1758), especially when it is sold fresh or frozen without the shell. The biggest problem occurs when consumers buy products stored in jars with a generic label of clams. These jars may contain different species from *Ruditapes* Chiamenti, 1900 as *Polititapes aureus* (Gmelin, 1791) or *Chamelea gallina* (Linnaeus, 1758) or with the *Meretrix* Lamarck, 1799, a species native from the Indian Ocean.

Another important fraud is connected with the cephalopods like *Todarodes sagittatus* Lamarck, 1798 (Teuthida Ommastrephidae), European flying squid, that sometimes is sold in the free fish market as *Loligo vulgaris* Lamarck, 1798 (Teuthida Loliginidae), European squid. One of the most blatant fraud regards the Mediterranean squid *Loligo vulgaris* that can be replaced by the defrosted *Uroteuthis chinensis* (Gray, 1849), Mitre squid, or *U. duvauceli* (Orbigny,1848), Indian squid, species that come from the Indian and the Pacific Ocean, respectively.

The Argentinean short-finned squid, *Illex argentinus* (Castellanos, 1960) (Teuthida Ommastre-

phidae) a species distributed along the western South Atlantic and imported frozen from Argentine, is sold defrosted instead of our common Mediterranean *Illex coindetii* (Vérany, 1837), broadtail short-finned squid.

Regarding cuttlefish, a common replacement is that between *Sepia pharaonis* Ehrenberg, 1831 (Sepiida Sepiidae), pharaoh cuttlefish, an Indo-Pacific species with the Atlanto-Mediterranean *Sepia officinalis* Linnaeus, 1758, common cuttlefish.

Among the octopus, species of the genus *Eledone* Leach, 1817 (Octopoda Octopodidae) are sometimes sold instead of *Octopus vulgaris* Cuvier, 1797. Others octopus species like *O. maya* Voss et Solis Ramirez, 1966 or *O. cyaneus* Gray, 1849 (which are Lessepssian specis and are considered as occasional in the western Mediterranean, see Zenetos et al., 2010) can be sold instead of the Mediterranean *O. vulgaris*. In all cases, fraud occurs when these products are sold fresh or frozen cut into small pieces.

FISH

Regarding fish species, there are some important example of commercial fraud. This is the case of the juvenile of sardines or anchovies ("bianchetto") that are replaced by the species *Neosalanx tangkahkeii* (Wu, 1931) (Osmeriformes Salangidae), known as "ice fish", species that comes from China and that is sold in the free fish markets and restaurants. Sometimes also juvenile of "rossetto" *Aphia minuta* Risso, 1810 (Perciformes Gobiidae), a small fish that reaches the maximum length of 6 cm, can be sold as "bianchetto".

If we look to the flat fish, there are many cases of replacement. This occur between "zanchette", i.e. fish of the genera *Lepidorhombus* Günther, 1862 (Pleuronectiformes Scophthalmidae) or *Arnoglossus* Bleeker, 1862 (Pleuronectiformes Bothidae) instead of the "sogliole", fish of the genera *Solea*. In some cases, consumers can buy instead of the *Solea solea* Quensel, 1806 (Pleuronectiformes Soleidae), two Atlantic specie the *Synaptura cadenati* Cantor, 1849, Guinean sole, or the Senegalese tongue sole *Cynoglossus senegalensis* (Kaup, 1858) (Pleuronectiformes Cynoglossidae).

Other very curios replacement of species concerns the "pangasio", *Pangasianodon hypophthalmus* (Sauvage, 1878) (Siluriformes Pangasiidae) imported from Asia (Vietnam), which is bred mainly in the Mekong basin and then sold in the markets as fillets of perch, *Perca fluviatilis* Linnaeus, 1758 (Perciformes Percidae). The "pangasio" has very little economical and nutritional value (it contains a lot of water, low protein and low amount of polyunsaturated fat). Another species that can be sold instead of the European perch, *Perca fluviatilis* is the Nile perch, *Lates niloticus* (Linnaeus, 1758) (Perciformes Latidae).

Among the Tunnidae family we have the difficulty to understand what species of tuna we are buying especially when this is sold in tins or jars; often companies reported in the pack the general label "tuna fish". Substitutions of species concern also the cartilaginous fish. This is the case of the blue shark, *Prionace glauca* (Linnaeus, 1758) (Carchariniformes Carcharhinidae) species subjected to the pressure of commercial fishing and sold some times for swordfish, *Xiphias gladius* Linnaeus, 1758 (Perciformes Xiphiidae).

FINAL REMARKS

It is important to be able to recognize the species, especially when these are considered over exploited or endangered or threatened and included in the Red List of the IUCN. This is the case, for example, of the shark *Prionace glauca*, a "near threatened species" (http://www.iucnredlist.org/details/39381/). The specific knowledge also allows us to properly estimate actual catches and then to adopt appropriate strategies for conservation.

For expert people, on the banks of the free fish markets it is easy to take a rip: a fish similar but of lower value can be sold for one more precious and of greater nutritional value. But if the fish is cleaned and filleted, even for experts recognize fraud is impossible.

In addition to the consequences of fraud, these "alien" fish create unfair competition against our national product. Moreover, if the fish of Italian origin are controlled thanks to laws and the "traceability" from the producer (fisheries, aquaculture, companies, etc.), for non-European Union controls are more difficult; lots from Vietnam or Africa could come from any control inspection.

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