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# OCCUPATIONAL ASTHMA IN MARITIME ENVIRONMENT

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## ABSTRACT

In the maritime environment, characterized by a great biodiversity, employees can be during their work exposed to chemical and above all biological substances. Some of them are the cause of occupational asthma. This is the case for some fished products such as crustaceans and mollusks and also for some products carried as cargo like cereals or chemicals used in the maintenance of ships. This article is a review of known etiological factors of occupational asthma (OA) to which seafarers and other maritime workers are likely to be exposed.

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## INTRODUCTION

Asthma affect from 5 to 10% of the general population in developed countries. The estimation of the proportion of work related asthma is between 4 and 10 % of the all asthmatic cases (1).

The maritime environment is characterized by the diversity of the products to which the different groups of workers in the maritime industry (merchant navy, fishing, harbor industry) are exposed.

Some etiological factors, mainly sea food, were particularly well known, recorded in the literature and studied, whereas others are transpositions to the maritime environment of diagnosed cases in general environment.

In the review of the literature of the subject and in personal cases reports, we collected data on the different known etiologies of occupational asthma in maritime environment. Even if this review does not claim to be, and could not be exhaustive, it is presented to help the medical practitioner to make the etiological diagnosis in dealing with the pathologies affecting seafarers.

## ASTHMA DUE TO SEA PRODUCTS

**Crustaceans**

Within this class of invertebrates, we find a species that, thanks to the works of the Canadian authors Malo and Cartier, is the example of specific asthma in maritime occupational environment (2, 3). It is the snow-crab (Chinoecetes opilio), for which the sensitization is made by respiratory ways through aerosols emitted during crab processing (4,5). In 1994, Endelman had already reported a high rate (70%) of asthma-like symptoms on a fishing boat (6). More recently, Beaudet found the prevalences of OA in fishermen from 4 to 6% aboard 5 crab-processing vessels (7). The other identified species for which the way of sensitization is similar to the snow-crab are : king crabs (Paralithodes camtschaticus) with a prevalence of OA of 9% in processing workers, common crabs (Cancer irroratus) with a prevalence of 7% in a processing plant, prawns (Nephrops norvegicus) with a prevalence of 36% in prawn workers and shrimps (Gammarus et Artemia salina) with a prevalence of 5% in one study about processing workers (8, 9, 10, 11, 12, 13). For the lobster (Homarus vulgaris et americanus), we have shown that the sensitization was caused through cooking steams (14, 15).

**Mollusks**

Some asthma cases were recorded for bivalves: mussels (Perna cannaliculus) with a prevalence of OA from 20 to 23% in mussels openers, clams with a prevalence of 2% in a population of processing workers and scallops (Pecten maximus) (16, 17, 18, 19, 20). Tomaszunas described asthma caused by the contact with cuttlefish in Polish fishermen with an incidence at 1% per year (21).

**Fish**

Some occupational asthmatic reactions to salmon were reported with a prevalence of 8 % in salmon processing workers (22). Some doubts exist for trouts, and a high probability for sole, hake and tuna (23, 24). These sensitizations, which are due to humid aerosols, were described in fish meal factory workers and in fish merchants but no case was described in fishermen (25).

**Worms**

Anisakis simplex, parasite infecting fish in a larval way, is recognized as an etiologic asthma agent (26, 27, 28). The first symptoms for the diagnosis of an infection by this parasite are mainly gastro-intestinal. An Italian study published in 2000 finds sensitivity to Anisakis in 50% of fishermen versus 0% for control subjects (29). Some asthma cases were also recorded during exposure to larva of Chironomus thumi thumi used as baits and food for tropical fish, as well as for mosquito larva (Echinodorus plasmosus), which can be found in aquariums (30, 31).

**Other sea products**

In a population of Japanese spiny lobster fishermen, 9% of them presented asthma following contact with a coral species (Dendronephthya nipponica) (32). Other species were also incriminated, particularly marine sponge (Dysidea herbacea), and an invertebrate from the Ascidiacea class living on oyster shells (Styela plicata) more known under the name of Hoya, with a prévalence of 29% in a population of oyster-workers (33, 34).

A case of asthma due to seaweed in thalassotherapists was published very recently (35).

For the aetiologies described in this part, asthma is almost always immunologic asthma with delayed sensitization, mediated by the IgeE, with the allergens present in the aerosol or cooking fumes (crabs, prawns, lobsters, shrimps, red coral, Anisakis). An association of allergic reactions type I and III, according to Gell and Coombs definition, are suspected for crabs, prawns and trouts. The levels of atmospheric allergens concentrations must be underlined. When we analyse those publications, we can conclude that the adequate ventilation system is the most important action in collective prevention of OA.

For the other aetiologies described in this article, it is difficult to make such synthesis because we described well-known OA aetiologies but with not many reports published on cases in maritime environment.

## ASTHMA DUE TO PRODUCTS CARRIED AS CARGO ON SHIPS

This part deals particularly with the seafarers of the merchant navy and the dockers who in the course of their work are exposed to various products, in maritime and non maritime environment, which are known to be the cause of occupational asthma. The risk is more important in harbors, as proved the studies carried out in Antwerpen, Barcelona and New-Orleans. (36, 37, 38).

Vegetal product

**Cereals**

The risk is predominant when the cereals are in the form of flours. The main cereal concerned is wheat which is a direct allergen, and the infectious products of flour which we shall describe below (39). Some cereals like barley, oats, rye, buckwheat and corn can also be a cause of allergic reactions (39, 40). Soybean flour is more allergenic than the crab. It is a particular case, and it was the cause of real over-representations of asthma prevalence in dockers and also among the residents of the Barcelona port from 1981 to 1987 (41). It is an OA mediated by the IgE, and a longitudinal follow-up of symptomatic subjects allowed to show persistent sensitization to soybean in 55% of them by skin and blood tests (42). It was also demonstrated in the residents of the New Orleans port in Louisiana (38).

Some cases were also described following the exposure to colza and groundnut oilcakes (39).

**Grains and seeds**

Green coffee beans are recognized as respiratory allergens able to induce immunological asthma. Some asthmatic cases were demonstrated in dockers (43). Castor oil, mainly in grains and sometimes in oilcakes, is a well known etiologic agent. But cases related to this agent were never found in seafarers or dockers (44). For cacao beans and aniseeds, cases are often described but not in maritime environment (45, 46).

**Wood**

The inhalation of small particles of many wood species is potentially allergenic or irritant. It concerns Northern woods such as the red cedar (prevalence at 12% in a population of Canadian wood workers), exotic woods such as the Manzonia bete, jatoba and more common woods like the pine (47).

The exposure occurs when workers make and repair wooden boats, and in dockers; but no reports on cases have been published yet.

**Leaves**

Tobacco leaves are directly the cause of IgE dependant asthma in workers who have the contact with them (48). They can also be the cause through the molds and actinomyces that they contain (39). Tea, while processing its leaves and above all when the workers are exposed to the tea dust, is another etiological agent of occupational asthma, probably immunologic asthma (49).

**Textile fibers**

The best known textile fiber, and which is the cause of a particular kind of occupational asthma called byssionosis, is cotton (50). We also note rarer cases for hemp, linen, kapok and coir (39). No cases among maritime environment workers have been described so far.

Like for tea and tobacco, dockers and seafarers may be exposed to textile fibers in loading or unloading boats and in cleaning ships.

**Infectious products**

The infectious products of flours are: storage dust mite, wheat weevil (Sittophilus granarius) and flour tinea (51, 52, 53). The infectious product of grains is Acanthoscelides obtectus in beans, and also the vegetal molds, mainly Alternaria et Aspergillus (39).

**Non marine animals contaminating the products carried as cargo**

The risk is known with American cockroaches (Periplaneta americana) but not with German cockroaches (Blatella germanica) (55).

It is also necessary to mention rats which are often found in ports and not so often aboard ships. Occupational asthma was diagnosed in laboratory technicians having contact with these animals. The allergen is contained in their urine. We can assume that the sensitization of seafarers can occur on ships following the contact with rats. The risk species seems to be the Rattus norvegicus (56). For those two aetiologies an immunologic mechanism has been proved.

**Chemical products**

In 1995, we described the case of a motorman who was exposed to vapours of phosphoric acid in the course of maintenance work on a ship (57). He presented a respiratory symptoms corresponding with a Reactiv Airways Dysfunction Syndrom (RADS), or Brooks syndrome, evolving towards a persistent asthma 3 years later.

We also mention the case of sudden death of one of his colleagues on board, who was also exposed to phosphoric acid following the leak of this substance. A diagnosis of legionellosis was suspected in Intensive Care Unit but the role of the exposure to phosphoric acid had not been totally dismissed. Before other cases of RADS induced by

phosphoric acid will be reported in literature, it is difficult for us to confirm that phosphoric acid was the aetiolgical factor of this case of OA.

Cases of RADS have been described after exposure to vapours of hydrofluoric, nitric and sulphuric acids (58, 59, 60). An old study conducted in 1967 proved the persistence and the link between the respiratory symptoms and the intensity of the exposure of dockers to chlorine gas during a leak of a cylinder (60). The other published case reports were not concerning maritime workers; but employees of maritime industry are exposed to those products.

## ASTHMA DUE TO OTHER EXPOSURES AT WORK

In this part, we discuss the other etiological agents to which the maritime workers are exposed.

**Performing routine duties**

A first case of occupational asthma due to sodium disulphite has just been published in a Norwegian lobster fisherman (61). Sodium disulphite is used in fishing to store fish and seafood (prawns and lobsters in particular).

For oceanographers, the use of varied and specific chemical products is frequent and can be the cause of asthma. Among them, we stress the role of formaldehyde that remains often used aboard (62).

**Maintenance work on ships**

The seafarers can be exposed to substances such as isocyanate during painting works, to amine and acid anhydride contained in glues and epoxy resins, to vapours of freons during the maintenance of refrigerated holds (63, 64, 65, 66, 67).

The role of coal tar as the causing agent of asthma was reported by Burstyn (68).

The antifouling paints containing fungicides like chlorothalonil can cause allergic reactions, a case of asthma due to this substance was recently published by Draper (69).

The maintenance of living and working space of the ship with the use of cleaning products that can contain ammonium compounds, chloramin and T chloramin, is a risky task for many seafarers (70, 71).

The exhaust gases of Diesel engines, and more particularly SO2, CO, CO2, aliphatic and aromatic hydrocarbons, can also be the cause of cases of asthma or exacerbation of its symptoms (72).

## CONCLUSION

This review of etiologies of occupational asthma in the maritime environment indicates for the great diversity of the phenomenon.

This indicates that there is a need for conducting further research on this problem affecting seafarers, dockers, and employees in the food-processing industry including maritime products.

The symptomatology of asthma and signs of dermatological or upper respiratory tract sensitization should be studied.

But paradoxally, we have to mention that asthmatic patients with reactions to herbal pollen, flowering plants or trees present less asthmatic reactions once at sea.

In France, diagnosing asthma as an occupational disease among seafarers has been accepted only since 1999. Such a short period of time of observation does not enable us to have enough distance for an analysis of this health problem for this occupation.

In our opinion, as it is the case for some risky occupations, large-scale epidemiological surveys among different groups of maritime workers should be conducted.

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