A REVIEW OF INTERNATIONAL BIOSECURITY POLICY DEVELOPMENT IN RELATION TO MOVEMENTS OF FRESHWATER CRAYFISH.

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ABSTRACT

Freshwater crayfish are frequently traded, both alive (for human consumption or for fisheries/aquaculture stocking) and as processed products (*e.g.* fresh or frozen, cooked or uncooked). As the experience in Europe with crayfish plague has shown, there can be significant risks of translocating pathogens with such trade. Such risks can be assessed in an import risk analysis process. This paper will concentrate on describing the principles of import risk analysis (IRA) with particular reference to freshwater crayfish.

Key-words : freshwater crayfish, exotic disease, import risk analysis, Government biosecurity policy.

SYNTHÈSE SUR LE DÉVELOPPEMENT DE LA POLITIQUE INTERNATIONALE DE BIOSÉCURITÉ CONCERNANT LES MOUVEMENTS D'ÉCREVISSES.

RÉSUMÉ

Des écrevisses sont fréquemment commercées, vivantes (pour la consommation humaine ou pour les besoins des pêches et de l'aquaculture) et en tant que produits traités (par exemple frais ou congelé, cuit ou cru). L'expérience en Europe avec la peste des écrevisses a montré qu'il peut y avoir des risques significatifs de transfert de pathogènes avec un tel commerce. De tels risques peuvent être évalués dans un processus d'analyse de risque d'importation. Cet article se concentrera sur la description des principes de l'analyse de risque d'importation (IRA), l'accent étant mis plus particulièrement sur les écrevisses d'eau douce.

Mots-clés : écrevisses, pathogène exotique, analyse de risque d'importation, politique de biosécurité du gouvernement.

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INTRODUCTION

Intracontinental translocations of freshwater crayfish have occurred for centuries (HOBBS, 1988; HORWITZ, 1990). However, intercontinental movement of humans and human-made objects, which is one definition for globalisation, has been accompanied by translocations of organisms, including freshwater crayfish, both intentionally (for agriculture or for pleasure) and unintentionally. Moreover, recent developments such as the common use of airfreight and the establishment of multilateral trade agreements have resulted in an increase in the movement of products, including perishables such as live aquatic animals and their products. The scientific community has long been aware of the biological risks inherent in such practices and representative organisations have lobbied governments to consider these risks when formulating biosecurity policy. The International Association of Astacology (IAA) has taken a lead role in representing the astacology community and at its seventh symposium adopted a resolution which called on Governments to introduce measures on the importation of live freshwater crayfish (Table I).

At the twelfth meeting of the IAA held in Germany in 1998, and the thirteenth meeting in Perth in 2000, fora were held to formulate a new resolution. The author was tasked with providing IAA members with a discussion paper on biosecurity policy development. This paper is partial fulfilment of that obligation.

Table I
The International Association of Astacology resolution.

Tableau I
Résolution de l'International Association of Astacology.

The Astacologists of the International Association of Astacology meeting in its seventh International Symposium in Lausanne, Switzerland, August 3-5, 1987, have noted:

- the damaging effects to live crayfish markets following the drastic decline in Turkish crayfish production,
- the marketing of new living crayfish species from many different places,
- the total absence of guarantees that such crayfish do not carry communicable parasites and diseases,
- the appearance of epidemics in European crayfish of aphanomycosis (the crayfish plague parasite), especially where it has not previously existed,
- the accrued risks of transmission of parasites and diseases, especially aphanomycosis, from other crayfish populations to native crayfish,
- the grave menace to native crayfish populations from introduction of undesirable exotic crayfish, and
- the potential for exposing fish to diseases and parasites born by crayfish.

Therefore, in view of the need for conservation of indigenous species and populations, we recommend that Governments find the means to stop the importation of living crayfish into their countries for any purpose (food, fish bait pets, etc.), except for governmentally approved research, restockings or introductions. Further, those Governments should be responsible for assuring that such living crayfish are parasite and disease free. Finally, Governments should encourage the restoration of native crayfish stocks wherever possible.

We encourage the immediate international adoption of this resolution.

THE INTERNATIONAL POLICY ENVIRONMENT - AGREEMENT ON THE APPLICATION OF SANITARY AND PHYTOSANITARY MEASURES

The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) was negotiated in the 1986-94 Uruguay round of negotiations under the General Agreement on Tariffs and Trade. Also arising from this round of negotiations was the establishment of the World Trade Organization (WTO) which, amongst other things, administers trade agreements such as the SPS Agreement and provides a mechanism for resolving trade disputes. The SPS Agreement provides rules for the use of measures which affect international trade, and have as their purpose the protection of human, animal and plant life or health in importing countries. Member countries are able to select their own appropriate level of protection (ALOP), but measures must be based on science and applied only to the extent necessary to provide the desired level of protection to human, animal or plant life or health. The SPS Agreement encourages Member countries of the WTO to base their measures on international standards, guidelines or recommendations where they exist. For animal health, the organisation recognised for developing international standards is the Office International des Epizooties (OIE). However, Members may adopt more stringent conditions if the international measures do not meet its ALOP. The SPS Agreement defines appropriate level of protection as « the level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory », and it is the sovereign right of each Member to determine this level taking into account any factors they deem appropriate. Importantly, the SPS Agreement requires that measures do not arbitrarily or unjustifiably discriminate between countries where identical or similar conditions prevail. In other words, in deciding on measures, a Member must apply an equivalent ALOP regardless of the source or type of product where the risks are similar. Clearly, the level of risk associated with importation will depend on a number of factors, including the product type and source country, and this is assessed by way of IRA.

BACKGROUND ON IMPORT RISK ANALYSIS

The Fish Diseases Commission is a Specialist Commission of the OIE which is responsible for compiling data on the diseases of fish, crustaceans and molluscs, promoting diagnostic, control or prevention measures for diseases of aquatic animals, as well as developing recommendations for trade in aquatic animals and their products. The Fish Diseases Commission is responsible for drafting the Aquatic Animal Health Code (referred to hereafter as the *Code*) and an accompanying Diagnostic Manual. The *Code* lists those diseases of aquatic animals which are classified as either « diseases notifiable to the OIE » or « other significant diseases ». Diseases which are listed as *diseases notifiable to the OIE* are transmissible and are considered to be of socio-economic and/or public health importance within countries and are significant in the international trade in aquatic animals and aquatic animal products (OIE, 2001). Diseases which are on the list of *other significant diseases* « are of current or potential international significance in aquaculture, but are less important than the notifiable diseases, or their geographical distribution is limited, or it is too wide for notification to be meaningful, or it is not yet sufficiently defined, or because the aetiology of the diseases is not well enough understood, or approved diagnostic methods are not available ». Crayfish plague is the only crayfish disease listed and it is on the list of *other significant diseases*. However, crayfish may be susceptible to infection (with or without clinical disease) by the causative agents of other OIE listed diseases of other aquatic animals.

The *Code* also outlines procedures for IRA, and states (OIE, 2001):

> The principal aim of import risk analysis is to provide importing countries with an objective and defensible method of assessing the disease risks associated with the importation of aquatic animals, aquatic animal products, aquatic animal genetic material, feedstuffs, biological products and pathological material. The analysis should be transparent. This is necessary so that the exporting country may be provided with clear and documented reasons for the imposition of import conditions or refusal to import. Transparency is also essential because data are often uncertain and the distinction between facts and the analyst's value judgements may blur.

The *Code* defines risk as the probability of an adverse event of aquatic animal health, public health or economic importance, such as a disease outbreak, and the magnitude of that event.

There are four components to risk analysis; hazard analysis, risk assessment, risk management and risk communication. In the hazard analysis, hazards (in the case discussed here after, a pathogen) which the commodity may present are identified and categorised as representing a potential risk to the importing country or not. Hazard identification must be done with full consideration of the pathogens which are present in the importing country, and whether these are the subject of official health controls. Clearly, there must be consistency between international and national biosecurity policy; a pathogen not considered to be a hazard in national biosecurity policy should not be considered a hazard in international biosecurity policy. By inference, a consistent approach to risk management should also be applied to equally hazardous pathogens in relation to national and international biosecurity policy; a pathogen of equal hazard as another pathogen present in the importing country which is not considered to be a hazard in national biosecurity policy should not be considered a hazard in international biosecurity policy when all other things are equal.

Components of risk assessment include the release assessment, the exposure assessment, the consequence assessment and the risk estimation. The release assessment provides an estimation of the likelihood that a pathogen will be « released » into the environment by importation of the commodity. Paramount in the assessment is knowledge of the occurrence of the pathogen in the source country (including an assessment of the quality of surveillance and treatment programs in that country), tissue distribution and resistance of the pathogen to processing and storage conditions. The exposure assessment provides an estimate of the likelihood that a susceptible species in the importing country will be exposed to the pathogen. Key considerations include demographics of susceptible species and of humans, whether the commodity is alive or dead, and intended usage of the commodity. In consequence assessment, the likely biological, environmental and economic effects of the introduction of the pathogen are identified and assessed. Risk estimation is a synthesis of the previous three components of the risk assessment to produce an estimation of the unrestricted risk of the entire pathway. If the level of unrestricted risk determined in the risk assessment of the commodity is greater than the ALOP of the importing country, then risk management measures are warranted.

Risk management is the process of determining and implementing measures which will have the effect of reducing the level of risk to one equivalent with the ALOP of the importing country or if this is not possible to a level below the ALOP. At the same time, the measures must be applied so as to minimise affects on trade. In other words, the aim is to introduce the least trade restrictive measure required to meet the ALOP. In doing so countries are encouraged to use the international standards developed by the OIE.

Risk communication is the process by which information and opinion on the risk analysis is exchanged between stakeholders, risk analysts and risk managers. A risk communication strategy should be initiated at the outset of the IRA, and should be established on the basis of transparency and interactivity, *i.e.* with the open and iterative exchange of information.

SCIENTIFIC DIFFICULTIES WITH IMPORT RISK ANALYSIS

Having a fundamental basis in science, IRA has a large appetite for large amounts of scientific information. Moreover, the better the quality of the information available, the more accurate will be the assessment. These data will often be available for significant pathogens of commercially important species. Many reviews on pathogens of aquatic animals stress the poor state of knowledge of disease causing agents in these species relative to the higher vertebrates on which traditional livestock industries are based. Reasons for this include the relative short history of culturing many aquatic species and the difficulties in observing disease in wild populations of animals which inhabit extensive water systems and which are rapidly consumed by predators and scavengers when they become ill or die.

Of equal or even greater significance is the lack of data on less economically significance pathogens. This statement may seem counter-intuitive as one might expect that the IRA should concentrate heavily on those pathogens which have caused significant losses; and IRAs do. Herein may lay the greatest inadequacy of IRA. The analysis must rely on information available at that time. The available information is typically obtained from field observations and laboratory research. Field observations in this case are typically analyses of the consequences of an unintentional exposure of one organism to another, and are retrospective. Therefore, when the consequence of such exposure is a serious disease outbreak, this information could be considered as resulting from a « past mistake ». Relying on past mistakes for indications of the likely consequences of introduction of an organism to a new habitat is highly undesirable. Moreover, the value of such analysis is dependant on the breadth of introduction of that organism.

To satisfy oneself on this point, only one question need be asked: « would *A. astaci* be included in a risk analysis on freshwater crayfish if it had not been introduced to Europe with American crayfish? ». Crayfish plague was introduced to Europe in the mid 1800s and has since spread widely on the continent, having a devastating affect on native species of freshwater crayfish. Furthermore, as *A. astaci* was known to be acutely pathogenic to native European freshwater crayfish, transmission trials were conducted and showed that Australian freshwater crayfish were similarly susceptible to crayfish plague (UNESTAM, 1976). Crayfish plague is now considered to be THE major disease of freshwater crayfish. However, crayfish plague is considered to be an insignificant disease in cultured and wild populations of freshwater crayfish in North America. In fact, the lack of pathogenicity of *A. astaci* to North American crayfish species casts considerable doubt as to whether it would have been reported as a pathogen of freshwater crayfish if a non-North American crayfish species had not been exposed. Following this hypothetical situation, even if *A. astaci* had been described as a potential pathogen of North American freshwater crayfish, it almost certainly would have been dismissed as an insignificant risk during the hazard analysis of an IRA.

In this case, North American freshwater crayfish have adapted to the fungus by developing an immune system capable of resisting serious infection (UNESTAM, 1976). Moreover, as it is not an evolutionary advantage for a pathogen to cause the extinction of its host(s), the pathogenicity of *A. astaci* for American species may have attenuated through evolution. In other words, the pathogen and host have reached a relatively stable state where, as long as the host does not suffer stress due to environmental alterations or

other infections, the pathogen will not cause disease in the host. This relatively stable relationship between a pathogen and its host, which is the consequence of a prolonged period of co-evolution, is considered to be very common in nature. When the pathogen is exposed to another organism, a potential host, the consequence may be that the organism is: refractory to infection, susceptible to infection but refractory to disease, or susceptible to disease. The outcome of exposure will be related to the degree to which the pathogen has evolved to infect the natural host, and how closely related is the potential host to the natural host. The mechanisms involved in such interactions are extremely complex, and are not well understood even for the most thoroughly studied disease conditions of higher vertebrates. Ultimately, the ability of a potential pathogen to infect and cause disease in a naive host is unpredictable (in practical terms, for some pathogens this may not be a concern if the likelihood of introduction can be accurately assessed as being negligible).

Laboratory trials may be an effective strategy to determine the susceptibility of a potential host to a known pathogen. Such trials pre-suppose that the natural routes of infection to the known hosts are well understood as it is paramount to replicate these routes in the laboratory. However, such apparently rudimentary information is very often unavailable even for important pathogens (*e.g. Thelohania*-like microsporidians and rickettsial infections in freshwater crayfish). Replication of natural and man-made ecosystems, including of aquaculture facilities, in the laboratory is close to impossible due to their infinite complexity, rendering extrapolation from such trials of limited value. Failed attempts to establish infection in a laboratory trial may be due to inadequate experimental design rather than being due to the organism being refractory to infection by the pathogen. Moreover, consequences of infection by pathogens in laboratory-held populations are unlikely to mirror the consequences of the introduction of that pathogen into natural or captive populations, and offer little information on the likely consequences on a regional or national level. Nonetheless, data from laboratory studies are of value to the risk analyst when there is only limited field data available or, as is often the case, no field data exist.

The disease status of wild organisms is not typically studied unless funding is prompted by a major decline in a population or entire species which is of commercial importance, or less commonly, is held in high regard by the community. As with farmed situations, in these cases research funding and effort typically focuses on pathogens which have been shown to cause serious disease. In general, funding for studies to determine the overall health status, and therefore the range of pathogens, of wild and farmed populations is difficult to obtain. Consequently, there often is a very poor understanding of the range of pathogenic fauna which affects many commercially traded organisms. Clearly, this poor knowledge seriously limits the accuracy of IRA, both in the ability of an analyst to assess the range of pathogens likely to be in imported product, and importantly, to assess the pathogens which are endemic in the importing country.

Article 5.7 of the SPS Agreement contains provisions for « cases in which the relevant scientific information is insufficient ». In such cases, the Member may adopt a temporary measure which is based on the available data. Moreover, the Member is obligated to seek to obtain the additional information required to perform a more objective assessment and carry out that assessment in a timely manner. The European Union has recently adopted a resolution on the use of the Precautionary Principle in matters related to the SPS Agreement (WTO communications G/SPS/GEN/168, 14 March 2000 and G/SPS/GEN225, 2 February 2001). One stated aim of the resolution is to avoid unwarranted recourse to the precautionary principle as a disguised form of protectionism and it emphasises the themes of the SPS Agreement, such as proportionality, consistency, transparency, and non-discrimination. However, the issue of responsibility for obtaining extra scientific data is not clarified. Rather the resolution suggests that this would be decided on a case-by-case basis.

PRACTICAL PROBLEMS OF IMPORT RISK ANALYSIS

This paper has, to this point, clearly focused on IRA process and scientific issues and deficiencies. To focus on these as the only important considerations would be exceptionally naive because, though IRA is undoubtedly a scientific-based analysis, politics is undeniably and inextricably entwined in the issue of importation which is a direct consequence of globalisation. At present, many countries have inconsistent biosecurity conditions on trade as much of the current policy is the result of geopolitical and domestic political history dating back centuries. Given that the SPS Agreement has been in existence for less than a decade, and that significant work is required for IRA, this situation is not surprising. However, issues relating to free trade create strong currents in domestic politics, and this is certainly hampering progress towards the development of biosecurity policy that fulfils SPS Agreement obligations. After all, it is public servants, who ultimately report to politicians, who are typically called upon to draft the policy and it is politicians who implement policy into law.

Politics surrounding this issue does not only act at the policy development stage. Now it is also affecting basic research. For instance, there may be a reluctance in some funding agencies to provide funds for basic research on disease agents of traded animals and plants for concern that pathogens may be detected which would require the introduction of biosecurity measures in importing countries. Additionally, international collaboration is being affected as Governments question the motives of foreign funding agencies and researchers, and the confidentiality of collaboratively obtained research data. Perhaps the greatest issue is one of conflicts of interest in domestic research funding. Governments in many countries are questioning their role as providers of research funding, even for basic research, and increasingly industries are providing the bulk of research funding. Clearly, it is difficult for researchers, who are key sources of information and opinion in IRAs, to publicly hold an opinion which is counter to that of the domestic industry. These constraints surely will have a damaging affect on scientific research in this area over the long term.

CONCLUSIONS

There is no doubt that animals and plants and their products will continue to be traded internationally. Though there are important deficiencies in scientific assessment of biosecurity risks accompanying such trade, it is important to have a mechanism which ensures science-based decision-making which delivers consistent outcomes when determining which products should be accepted or rejected for importation on the basis of these risks. In the absence of such mechanisms, history shows the biosecurity measures will be used indiscriminately by Governments to stop trade in some commodities from some countries, while accepting far greater biosecurity risks with other commodities and/or with the same commodity from other countries.

Zero biosecurity risk is unattainable in practical terms. To attempt this all international boundary movements would have to be outlawed, and there would still be illegal movements with which to contend. Moreover, measures would need to be introduced to prevent natural migratory patterns of animals, natural dispersal mechanisms for plants, and prevent air and oceanographic currents from crossing international boarders. Human beings naturally accept certain levels of risks in their own lives and so movements of commodities must be approached similarly. The key issue is public awareness through dissemination of information and education so that all stakeholders are aware of the risks, costs and benefits of trade.

Researchers will continue to play vital roles in IRA processes, as providers of research data and well-reasoned scientific opinion to Governments and other stakeholders, including the general public. However, researchers must be mindful that, although their focus may be concentrated on one particular species, group of species or ecosystem, biosecurity policy must be developed consistently across a range of animals, plants and products. It is the sovereign right of Governments to determine the level of risk that will be accepted when importing products, but in democratic countries it is the right of citizens to determine who forms Government.

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