



Minireview

Health management during handling and live transport of crustaceans: A review

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ABSTRACT

Best practice approaches used in the live transport of commercial crustacean species groups are reviewed and the physiological responses to handling practices are described. Codes of practice aimed at providing technological guidelines in handling and transportation of live prawns, lobsters, crabs and freshwater crayfish are examined. While some handling and transport practices are common across species groups, for example purging and chilling, recommended practices vary with species group. The influence of stress responses on health and survival during live transport is discussed and research investigations on the effect of stressors, in particular air exposure, handling and physical disturbances and temperature fluctuations on physiological processes are reviewed for the six species groups, crabs, freshwater crayfish, clawed and spiny lobsters, freshwater prawns and marine prawns. Investigations on the assessment of immune responses to live transport stressors using haemograms, clotting times, phenoloxidase activity, phagocytic activity, bacteraemia and antibacterial activity and haemolymph protein concentration are described. A combination of physiological parameters is desirable in the assessment of stress response or health status in crustacean species transported live to seafood markets.

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Table 1
Crustaceans marketed as live product.

Species group	Species	Reference
Crabs	<i>Callinectes sapidus</i>	Ewart (2000)
	<i>Cancer magister</i>	Cascorbi (2004) and www.wcsmpa.org
	<i>Cancer pagurus</i>	Chartois et al. (1994), Stentiford et al. (2002) and Robson et al. (2007)
	<i>Carcinus maenas</i>	Robson et al. (2007)
	<i>Maja squinado</i>	Chartois et al. (1994)
	<i>Necora puba</i>	Chartois et al. (1994), Robson et al. (2007) and www.aquareg.com
Crayfish (freshwater)	<i>Scylla spp.</i>	www.nabard.org
	<i>Cherax destructor</i>	Staniford (1989), Piper (2000) and www.pir.sa.gov.au
	<i>Cherax quadricarinatus</i>	Jones (1990), Piper (2000) and www.pir.sa.gov.au
	<i>Cherax tenuimanus</i>	Jussila et al. (1999)
	<i>Procambarus clarkii</i>	Romaire et al. (2005)
	<i>Procambarus zonangulus</i>	Romaire et al. (2005)
	Lobsters (clawed)	<i>Homarus americanus</i>
<i>Homarus gammarus</i>		Whiteley and Taylor (1992) and Chartois et al. (1994)
<i>Nephrops norvegicus</i>		Jacklin (1996), Schmitt and Uglow (1997a,b), Stentiford and Neil (2000), Ridgway et al. (2006) and Jacklin and Combes (2007)
Lobsters (spiny)	<i>Jasus edwardsii</i>	Taylor et al. (1997) and Linnane (2007)
	<i>Palinurus elephus</i>	Chartois et al. (1994)
	<i>Palinurus mauritanicus</i>	Chartois et al. (1994)
	<i>Palinurus regius</i>	Chartois et al. (1994)
	<i>Panulirus argus</i>	Mathews (2001) and Kelly (2003)
	<i>Panulirus cygnus</i>	Jussila et al. (1997), Paterson and Spanoghe (1997) and Spanoghe and Bourne (1997, 1999)
	<i>Panulirus homarus</i>	Vijayakumaran and Radhakrishnan (1997) and Immanuel et al. (2006)
	<i>Panulirus japonicus</i>	Huang and Chen (2001)
Prawns (freshwater)	<i>Macrobrachium rosenbergii</i>	Coyle et al. (2001, 2005), Tidwell and Coyle (2002), Salin (2005), Tidwell et al. (2005), www.isuagcentre.com and www.msucare.com
	Prawns (marine)	<i>Pandalus platyceros</i>
<i>Penaeus chinensis</i>		Ling et al. (1996)
<i>Penaeus indicus</i>		Babu and Marian (1998)
<i>Penaeus japonicus</i>		Shigueno (1975, 1992), Goodrick et al. (1993, 1995, 1997), Paterson (1993a,b) and Hewitt and Duncan (2001)
<i>Penaeus monodon</i>		Paterson (1993b), Ling et al. (1996) and Salin and Jayasree-Vadhyar (2001)
	<i>Penaeus vannamei</i>	Jiang et al. (1995), Ling et al. (1996) and Browdy and Jiang (1997)

1. Introduction

Seafood is highly perishable and more than 90% of international trade is based on processed products. However, live fish/shellfish are particularly appreciated in Asia and in other niche markets where aquariums and tanks displaying live fish in seafood restaurants, supermarkets and retail outlets are becoming increasingly common. Transport and storage of live crustaceans has been made possible through technological advances including specially designed or modified tanks and containers, as well as trucks and other transport vehicles equipped with aeration or oxygenation facilities. Technological developments have been underpinned by physiological studies of the effects of environmental stressors on health status conducted both in the laboratory and on fishing vessels and transport vehicles. Stress physiology has been studied in a number of crustacean species. The aim of this review is to document the influence of physical and environmental stressors on health status and physiological processes in crustacean species and evaluate findings in the context of health status and survival during live transport. Particular attention is given to studies performed on species that form the basis of a commercial fishery or aquaculture industry and are marketed as live product.

2. Commercial species marketed as live product

Crustaceans that are marketed as live product include clawed and spiny lobsters, crabs, marine and freshwater prawns and freshwater crayfish (Table 1). Countries marketing these products include Taiwan, Korea, China, Australia and Thailand (marine prawns), India and USA (freshwater prawns), Canada, USA and the United Kingdom (clawed lobsters), Australia and India (spiny lobsters), Ireland, United Kingdom, Norway, Canada, India and Australia (crabs) and

Australia, Spain and USA (freshwater crayfish) (Chetrick 2006; Aquareg, www.aquareg.com; www.austrade.gov.au; FAO Fisheries, www.fao.org; www.isuagcentre.com; www.msucare.com; www.nabard.org; WCSMPA, www.wcsmpa.org).

3. Live transport procedures

Various approaches have been developed to maximise health and survival during transport including packaging in chilled sawdust or hessian or immersion in specially designed tanks or viviers. Anaesthetics are sometimes used, particularly with marine prawns, but they are not approved for use in some countries such as the USA. Several Codes of practice have been established to provide technological guidelines in handling and transportation of live crustaceans (e.g. APEC, 1999; Codex Alimentarius 1983; Animal Welfare Guidelines; Aquatic Animal Health Code 2007). As crustaceans vary in their tolerance to environmental perturbations, recommended practices vary by species. However, most crustaceans destined for live markets are chilled prior to transport to reduce stress.

APEC guidelines (1999) detail procedures for reducing stress in packing and transport of a number of live crustacean species groups. According to these guidelines, live shrimp should be cooled to achieve lethargy. As rapid chilling can cause loss of legs and claws, the temperature should be lowered slowly. Packing in pre-chilled sawdust or wood shavings is used to minimise stress while some species such as black tiger shrimp (*Penaeus monodon*) and freshwater prawns (*Macrobrachium rosenbergii*) can be packaged in oxygenated water in plastic bags.

Live lobsters are prone to stress from temperature shifts, low humidity, low oxygen and overcrowding (APEC, 1999; Stevens, 2004). Clawed live lobsters may also suffer from cannibalism and

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