Freshwater crayfish as biomonitor

Australian IAA member Marilyn Bennett-Chambers was recently awarded her PhD for investigations into the role of *Cerax cainii* (marron) as a biomonitor of the impact of cadmium on aquatic ecosystems.

“*Cerax cainii* (Austin & Ryan): a biomonitor of cadmium”

**ABSTRACT**

Cadmium (Cd) is a non-essential trace metal found in the aquatic ecosystems of Western Australia (WA). This metal enters aquatic ecosystems in WA as a by-product of prolonged superphosphate application to agricultural land. Measurement of Cd concentrations in the water column does not reflect the true impact of Cd on aquatic organisms because many of them have the ability to concentrate Cd from low ambient concentrations; further, not all Cd present is bioavailable.

One method of monitoring these ecosystems is to estimate the impact of Cd in an organism within this system. *Cerax cainii* (marron) is a freshwater crayfish endemic to southwest WA and this study investigated the hypothesis that this crayfish could be used as a biomonitor of cadmium (Cd) in the southwest aquatic ecosystems of Western Australia.

Cadmium concentrations in *C. cainii* were measured under different situations to elucidate the factors that may influence Cd accumulation. Acute exposure experiments conducted over 96 hours investigated Cd sensitivities, mortality patterns, and accumulated concentrations in whole, juvenile marron. A comparison was made between marron of different ages (3 and 6 months) from Pemberton and marron of the same age from Pemberton and Geraldton. This was followed by a chronic study that exposed 18 month old marron to 15 µg Cd L⁻¹ for 30, 60 or 90 days.

Cadmium accumulation was measured in the hepatopancreas, gills and abdominal muscle in both control and exposed animals. Concomitantly, Cd metallothioneins were measured in the hepatopancreas of these marron. The Pemberton pond study quantified Cd concentrations in the same three tissues in known aged marron. A cross-sectional study involved the sampling of a cross-section of marron aged between 0-3 years across the different seasons of one year. Winter and spring sampling of juveniles in this study (Continued on page 4)
Applications should be directed to the Vice-Chancellor and mailed so as to arrive at Uppsala University, Registrar’s Office UFV-PA 2003/5903, Box 256, S-751 05 Uppsala, Sweden, or fax +46 18 471 2000, no later than February 23rd, 2004. A fax should be followed by a signed original of the application sent within a week of the deadline.

**LITERATURE OF INTEREST TO ASTACOLOGISTS**

which has extensive populations of white-clawed crayfish, a policy of not allowing NICS to be imported, and no outbreaks of crayfish plague since the mid-1980s.

**HARVEST AND PLAGUE RESISTANCE IN CRAYFISH IN TURKISH LAKES**

Harlıo (2004) (see Literature of Interest to Astacologists) has reviewed the status of the crayfish (Astacus leptodactylus) harvest in Turkish lakes since its decline due to overfishing and crayfish plague in the mid-1980s. According to the author crayfish are not cultivated in Turkey at present, and very little of the catch is eaten, most being exported to Western Europe. The harvest has been steadily increasing in recent years and was 1500 tonnes in the 1998 season. The bulk of the production comes from Iznik Lake (Bursa) which, despite having been affected by crayfish plague, has a thriving population of A. leptodactylus. Eğirdir (İsparta) Lake used to be one of the best crayfish lakes in Turkey but was badly affected by crayfish plague. Harvesting was banned from 1987 to 1999 due to the presence of the disease. In 1999 some 500 tonnes were harvested, although over 13% exhibited characteristics of the disease.

**EDITORS’ NOTE: MAGNUS FÜRST OF SWEDEN (CRAYFISH NEWS 9(2) 1986) NOTED THAT CRAYFISH IN TURKISH LAKES SHOWED SIGNS OF RESISTANCE TO CRAYFISH PLAGUE AND THAT THE DISEASE WAS POSSIBLY SPREAD BY WATERFOWL.**

**COMPARATIVE PHYSIOLOGIST REQUIRED**

The post of Assistant Professor/Research Associate in Comparative Physiology at the Department of Comparative Physiology, Evolutionary Biology Center (EBC), Uppsala University is available.

**Period of appointment:** The position can be held for a maximum of four years.

**Tasks:** The position is for research in molecular and comparative immunology and the successful applicant will join an already existing group working with innate immune reactions in invertebrate animals and contribute with his/her

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**SIGNALS THROUGH THE GRINDER!**

Member Stephanie Peay (UK) has sent in the following abstract and asks the question “Will nothing stop these animals?”


**Abstract:** Methods to contain the spread of nuisance or otherwise undesirable fish species are relatively limited. I describe an unconventional method used to help restrict the movement of northern pike Esox lucius from a mountain reservoir into downstream waters. Reservoir managers designed, installed, and monitored steel structures (“graters”) that served to increase the likelihood that fish entrained in discharge from Lake Davis (Plumas County, California) would incur fatal trauma. Seven species of fish, cumulatively hundreds of individuals, were observed killed by the graters. Injuries induced included dismemberment, lacerations, abrasions, and contusions. No failures to induce fatal trauma to entrained fish were observed, though a few crayfish Pacifastacus spp. remained alive after only partial dismemberment. The graters were fabricated from commercially available steel and sized to fit over 10-in and 30-in discharge ports of the outlet works. Reservoir and fishery managers could adapt these designs for use at a variety of other outlet facilities where interim measures are desired to contain the spread of nuisance fish.
Marron accumulated Cd in proportion to the concentrations to which they were exposed in the acute exposure study. Acute toxicity tests with juvenile C. cainii resulted in 96 hr LC50s that ranged from 0.4 to 4.7 mgCd L\(^{-1}\). Pemberton 3 month old marron had lower initial total body Cd but were more sensitive to Cd, accumulated it faster and sequestered Cd to higher concentrations than the Geraldon 3 month and Pemberton 6 month juvenile marron. Overall, the Geraldon 3 month and Pemberton 6 month marron were the same size, had the same LC50s and accumulated Cd at similar rates. Cherax cainii accumulated bioavailable Cd from the surrounding water in the chronic exposure experiment. The hepatopancreas accumulated Cd continually with no evidence of depuration over 90 days. The gills accumulated the highest concentrations of Cd during the exposure, and after an initial 30 days uptake maintained a high but variable concentration of Cd. The concentrations in the abdominal muscle were much less than in the gill and hepatopancreas but there was an initial increase at 30 days, which probably reflected the Cd contribution from haemolymph from the haemal spaces between the muscle bundles. Moulting appears to be one method of Cd depuration. 

The Pemberton pond study demonstrated that C. cainii accumulated of Cd over time. However, accumulation of Cd in the three tissues paralleled the growth of the marron. This caused a dilution effect for tissue Cd over time that resulted in an overall decline of Cd concentrations in the hepatopancreas, muscle and gills. This trend was identified in animals over eleven months old. Variability in Cd concentrations within the older animals was generally short-term and tissue specific which reflected seasonal fluctuations in available Cd moderated by changing growth patterns throughout the year. Cadmium metallothioneins were investigated as a potential biomarker for Cd. These Cd metallothioneins (CdMTs) were present in marron exposed to Cd, but were not detectable in the control animals. The highest Cd metallothionein concentrations coincided with an increased Cd burden in the hepatopancreas. Cadmium and CdMT concentrations gradually increased over the exposure period and were greatest in the marron exposed for 90 days. Cadmium metallothioneins may be a more sensitive measure for Cd flux in the aquatic ecosystems than Cd tissue concentrations. 

Cerax cainii can be a biomonitor of Cd in the aquatic ecosystems of the southwest of WA under the following circumstances: 

- Long-term monitoring or spatial comparisons can be made if the sampling regime measures Cd in the hepatopancreas from internoulum males, especially if the age of the marron is known, or at least approximated.
- The sample should not include juveniles.
- There should be seasonal collections or an annual collection in autumn.
- The most recent Cd exposure can be monitored using gill tissue.
- The collection areas should have rainfall records available.

This study highlights the presence of Cd in the aquatic ecosystems of the southwest of Western Australia and the potential use of Cherax cainii as a biomonitor that can be incorporated in future management strategies. 

2. The Zeta River (tributary of the MoraČa River) in Montenegro has A. pallipes. 

The information was based on specimens collected in 2002 (National Museum, Prague, inventory No. P6E-2866). A. pallipes were found in this river at Spač and Peračica (both visited 28 Aug. 2003). It is the first time that A. pallipes have ever been found in Montenegro. According to Karanam's classification (1962), these crayfish should be A. pallipes caricus. 

3. The Crnojevica and Orohovštica drainages (Skadar Lake, Montenegro) have A. torrentium. 

The tributaries of Skadar Lake are known to hold A. torrentium (Karanam 1981). The Crnojevica River at Rijeka Crnojevica, the Radunir Brook below Gradani (tributary of the Orohovštica), and the Velja River at Otvočići (headwaters of the Orohovštica) were observed and A. torrentium were found in all these places (all visited 29 Aug. 2003). 

4. The Marica River at Septemvri in Bulgaria has A. torrentium. 

The Naturhistorisches Museum in Wien has A. torrentium collections sampled in the Marica River at Sarambei (now Septemvri in Bulgaria, NHMW inventory No. 3035). Specific verification of the collections was carried out in Wien, these are in effect A. torrentium. This location was erroneously interpreted as a place in Turkey (Stagl & Dworschak, 1998). The habit of the Marica River in Turkey is not good for A. torrentium, but it is for a freshwater crayfish (Potamon ibercium), and probably also for Astacus leptodactylus (Machino, personal observation 1996). 

Crayfish sampling trips in 2003 enabled us to obtain information from Poland, Czech Republic, Slovakia, Hungary, Romania, Serbia, Montenegro, Bosna-i-Hercegovina, Austria, Germany, Italy, France, and Spain. The distribution data and the genetic data will provide useful information on the biogeography of Austropotamobius spp. of Europe, as several Austropotamobius specimens from Portugal, Spain, France, Luxembourg, Germany, Austria, Italy, Slovenia, Croatia, Montenegro, Greece, and Turkey have already been analyzed (Machino et al., in prep.).

The authors thank P. C. Dworschak, D. M. Holdich, B. Sket, R. Šanda, and P. Trontelj for their help. 

**Literature cited**


INVERTEBRATE REPRODUCTION AND DEVELOPMENT CONGRESS

IAA member Amir Sagi sends the following conference announcement:

10th INTERNATIONAL CONGRESS ON INVERTEBRATE REPRODUCTION AND DEVELOPMENT (ICIRD) to be held:

DATE: 18 to 23 July 2004
LOCATION: Newcastle upon Tyne, UK
WEB SITE: http://www.ncl.ac.uk/icird2004

MEMBERSHIP NUMBERS

During the current period (2002-2003) there have been some 318 members in the IAA. In addition, there are currently 129 members of the Forum Flusskrebs, an organization for German-speaking astacologists that is affiliated to the IAA. On a regional basis 19 come from Africa, Middle East and Far East; 19 from Central and South America; 98 from North America; 148 (+129) from the Europe and the Near East; and 34 from Australasia and the Pacific Islands. Numbers for most regions have remained similar or have increased slightly since the last census in 1996-97, although the number of North American members has declined since then.

NEW EDITION OF CRAYFISH BOOK

A 4th edition (2004) of Jacques Arrignon's book 'L'écrevisse et son élevage' (ISBN 2-7430-0637-4) has been published. This book mainly deals with crayfish farming but also has details of general biology. Yoichi Machino (France) reports that the book contains a lot of new information and is generally error free. It is in French and costs 55 euro. Further details can be found at: http://www.tec-et-doc.com

MONOPHYLETIC ORIGIN OF CRAYFISH

The Decapoda, to which the freshwater crayfish belong, is thought to have at least 10,000 species, and may be at least half as large again. Dixon et al. (2003) (see Literature of Interest to Astacologists) have postulated a new hypothesis of decapod phylogeny. The study was based on computerised cladistic analysis of the external morphology of some 60 taxa of decapod crustaceans, including five species of crayfish: Astacus astacus, Austropotamobius pallipes, Cambarus bartoni, Cambaroides japonicas, Astacoides madagascarensis and Cherax lorentzi. The authors conclude that homarids (lobsters) and astacids (crayfish) are closely related, as shown by the unique process on the ischium of their first pereopods. Other recent studies have tried to separate the true lobsters from the freshwater crayfish. Their analysis does support the monophylogetic origins of freshwater crayfish – but not strongly. However, they do state that embryological evidence gives considerable support to their monophylogeny.

CRAYFISH IN LAKE GENEVA

Dubois et al. (2003) (see Literature of Interest to Astacologists) report on catches of crayfish from the French shore of Lake Geneva. Although Astacus leptodactylus appears to have virtually disappeared, some fifty tonnes of the alien species, Orconectes limosus and Pacifastacus leniusculus, were caught along 30 km of shore in 2001. This represents a quantity of 1800 kg per km. The authors consider that the annual yield is amongst the highest of European lakes, although is in accordance with values observed in French ponds and gravel pits.

NEW DATA AND VERIFICATION ON THE GEOGRAPHICAL DISTRIBUTION OF THE CRAYFISH GENUS AUSTROPOTAMOBUS FROM BOSNA-I-HERCEGOVINA, MONTENEGRO AND BULGARIA

During the summer of 2003 several countries in Eastern and Southeastern Europe as well as some local institutions were visited in order to gather information on the geographical distribution of Austropotamobius spp., and to verify the crayfish information. The most significant findings were:

1. Trebinje area in Bosna-i-Hercegovina is inhabited by Austropotamobius pallipes.

The Trebišnjica River at Trebinje and the Sušica River at Aranđelovo (tributary of the Trebišnjica) (both observed 31 Aug. 2003) have A. pallipes. According to Karaman's...
References


Koksal, G. (1997). Biometric analysis on freshwater crayfish (Astacus leptodactylus) which is product in Turkey. Relationship between the major body components and meat yield. Journal of the Faculty of Veterinary Medicine, University of Ankara, 26: 94-114.


IAA HISTORY BOOK UPDATE

Apart from some minor details, David Holdich and Glen Whisson have completed the IAA History Book. We hope to launch the publication in London and distribute a copy to all members and make it a standard issue for new members. We are still uncertain of the identity of one lady who appears in pictures from some of the early symposia. We are quite sure she is either Mrs Mary Mason (John Mason’s wife) or Mrs Spitz (Reinhard Spitz’s wife). If you can provide further information it would be greatly appreciated. In these pictures she appears with Stellan Karlsson (below left) and Per Brinck (centre). If you can help, please email Glen Whisson (g.whisson@curtin.edu.au) urgently as the book will go to print within a matter of days.