

# Crayfish NEWS

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stage oocytes, with a small number of oocytes at the early yolk stage. The gonadosomatic index of the AG-implanted females was significantly lower than that of the control (sperm duct-implanted or sham-operated) females, which had mature oocytes with a well-defined perinuclear zone and yolk globules. An immunohistochemical test using an antibody developed against a 106-kDa secondary vitellogenic polypeptide showed only slight immunoreactivity in the oocytes of AG-implanted females compared with abundant immunoreactivity in control ovaries.

In the polypeptide profile of the high-density lipoprotein (HDL) from the hemolymph of AG-implanted females, the 206- and 79-kDa secondary vitel- logenesis-specific polypeptides were not found, whereas they were present in the profile of control females. In contrast, the female-specific 177-kDa polypeptide was present in the polypeptide profile of hemolymph HDL of both AG-implanted females and control females. It seems that while secondary sex characters were masculinized under the influence of the implanted AG, the process of vitellogenesis was suppressed but not fully eliminated in the AG-implanted females.

## PAPERS OF INTEREST TO ASTACOLOGISTS

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12. Parkyn SM, Collier KJ, Hicks BJ. 2001. New Zealand stream crayfish: functional omnivores but trophic predators?. *Freshwater Biol.* 46(5):641-652.
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14. Sullivan JM, MacMillan DL. 2001. Embryonic and postembryonic neurogenesis in the ventral nerve cord of the freshwater crayfish *Cherax destructor*. *Journal of Experimental Zoology*. 290(1):49-60.
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The white-clawed crayfish facing an uncertain future in the UK

## ALIEN CRAYFISH CONTROL

The white-clawed crayfish, *Austropotamobius pallipes*, faces an uncertain future in the UK, where it is vulnerable to direct competition from introduced species such as the American signal crayfish, *Pacifastacus leniusculus*.

This aggressive alien species can also carry a virulent fungal disease, which causes Aphanomyces (commonly known as crayfish plague), to which it is itself largely immune unlike the highly susceptible native crayfish. Outbreaks of this disease have wiped out entire sub-populations of native crayfish, displacing them from whole river catchments.

The Environment Agency plays a key role in protecting the white-clawed crayfish, in fulfilment of its role as 'Contact Point' for the species UK Biodiversity Action Plan. One important area, which has recently been the subject of considerable research by the Agency and partner organisations, has been that of alien crayfish control.

This year sees the completion of a research & development project which has examined potential methods for the eradication or control of non-native crayfish ("Eradication of Alien Crayfish Populations", R&D Project W1-037). The work, jointly funded by the Environment

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The International Association of Astacology (IAA), founded in Hintertal, Austria in 1972, is dedicated to the study, conservation, and wise utilisation of freshwater crayfish. Any individual or firm interested in furthering the study of astacology is eligible for membership. Service to members include a quarterly newsletter, membership directory, bi-annual international symposia and publication of the journal *Freshwater Crayfish*.

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#### President's Corner

On 8 July I fly to Melbourne, Australia, to participate in ICC5, the Fifth International Crustacean Conference. There will be several presentations related to freshwater crayfish and I will endeavour to pass any interesting information on to members. My wife, Tania, and I have produced another IAA poster and I will be hoping to attract new members with it during the conference. If you are attending let me know and we can have "IAA drinks".

After Melbourne I will be hosted in Mexico by **Pedro Joaquín Gutiérrez Yurrita**. The purpose of the visit is to see how preparations are progressing for IAA 14, to be held in Queretaro in August 2002. If you have any queries or suggestions regarding IAA 14 (e.g. e-mail facilities, family accommodation, tours, etc), please e-mail me at: [c.g.whisson@curtin.edu.au](mailto:c.g.whisson@curtin.edu.au). I will be checking this address daily.

Included with this issue is the last instalment of the IAA History booklet. **David Holdich** has put a lot of effort into producing this series and we intend to combine all parts and print a more permanent publication. So please, if you notice any mistakes, let David or myself know so we can correct them prior to the final printing.

Discussions are underway with IAA member **Manfred Poeckl** from Austria on the formation of an IAA sub-group from Austria, Germany and Switzerland. Representatives will hold a meeting following the Poitiers conference in September. Contact Manfred if you are interested in being involved: [Manfred.Poeckl@noel.gv.at](mailto:Manfred.Poeckl@noel.gv.at)

We are now considering proposals for IAA 15 in 2004. We already have one offer from London that will be presented in Mexico. If you are interested in hosting IAA 15 please contact me.

IAA member **Louis Evans** is battling a serious illness at present. Please uphold Louis in your prayers and let's hope we see our friend back on her feet very soon.

Glen Whisson  
IAA President

(Continued from page 1)

Agency and English Nature, has looked at a series of real life case studies, each utilising a different method in an attempt to control unwanted alien crayfish populations. The project has looked at mechanical, biological and physical techniques, and has also tested chemicals as potential control agents.

Findings have shown that the eradication of established populations of alien crayfish will be difficult to achieve. However, one recommendation of the project concerns a potential new method for enhancing the effectiveness of some of the above techniques through the use of crayfish pheromones and chemical signals.

Crayfish possess sensitive chemo-sensors, which they rely on to help locate food and mates, and to avoid aquatic predators. Harnessing the chemicals involved (e.g. to improve the efficiency of traps) could offer a previously unexplored management option in the battle to protect the native species.

To this end, a new partnership between the Environment Agency and English Nature has seen the start-up, in March of this year, of a Research & Development Project, which will investigate the potential use of chemical signals and pheromones in the control of invasive crayfish species. ("The use of chemical signal molecules to manage aquatic pests: Evaluation of the capacity of pheromones for the eradication of invasive non-native crayfish", R&D Project W1-070).

The work, which will be carried out by a team from the Universities of Portsmouth and Newcastle, is scheduled to run for the next two years, comprising a combination of behavioural studies, specificity testing, chemical analysis, field trials and computer modelling. It is the hope of conservationists that this research could provide the scientific information required to help devise a nationally consistent strategy for the control of alien crayfish, and their eradication from key areas.

#### Contacts:

R&D W1-037: **Julie Bywater** (EA, Thames Region)

R&D W1-070: **Pete Sibley** (EA, Midlands Region)  
Richard Jennings

(EA, N-East Region)

David Fraser (English Nature,  
Peterborough)

#### MEET YOUR IAA STUDENT REPRESENTATIVE

Hi my name is **Mark Pagano**, student representative for the IAA. I am currently completing a Bachelor of Science degree in 'Aquatic Resource and Fisheries Management' at Curtin University, Western Australia. If there is any interest among members to help students with a passion for crayfish to get to the 14<sup>th</sup> symposium in Queretaro, Mexico next year please let me know.

I am sure there are many institutions worldwide like Curtin University, that have interests in astacology. Our studies here at Curtin include ongoing research in aquaculture related fields with the native crayfish marron, *Cherax tenuimanus*, and the introduced yabby, *Cherax albidus*. Work also continues on the impacts of translocated crayfish and finfish on our native crayfish and the ecology of our freshwater rivers and dams.

It would be great to see plenty of students giving presentations of their work at the next IAA symposium in Mexico.

I would like to start an IAA student fund, to be managed by the Board (under advice from student members!). If anyone has suggestions on how we could raise money, please let me know. Better still, if anyone wishes to make a donation it would be greatly appreciated. The money could go directly to students attending conferences, offset the costs of student functions, or help keep student registrations to a minimum.

Mark Pagano  
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WESTERN AUSTRALIA

## CRAYFISH SYMPOSIUM HELD IN POLAND

IAA member Witold Struzynski from Warsaw Agricultural University in Poland sends details of the inaugural meeting of Polish astacologists last year.

The first symposium of Polish astacologists, titled "Present status of crayfish in Poland", was held on 6 October 2000 in the Chair of Inland Fishery and Aquaculture of the Agricultural Academy in Poznan. The meeting aimed at presenting crayfish studies carried out by various teams in Poland. In most cases these studies are of preliminary nature and intended to reactivate Polish astacology orphaned by Józef Kossakowski - an honorary member of the IAA who passed away 11 years ago.

The symposium was organized by Prof. Jerzy Mastynski and Dr Wojciech Andrzejewski, both from Poznan. Thirty six people from five scientific institutions, one fish farmer and numerous students attended the symposium. Twelve oral contributions presenting the research trends of particular teams were delivered. Prof. Jerzy Mastynski, chief of our host chair, opened the oral sessions and the initial presentation was given by W. Andrzejewski, who demonstrated the population status of crayfish in waters of Western Poland with particular reference to the noble crayfish (*Astacus astacus*). Then the situation of native crayfishes was presented by Przemyslaw Smietana from the Szczecin University, who concentrated on the narrow-clawed crayfish (*Astacus leptodactylus*), and by W. Struzynski from the Warsaw Agricultural University, who presented the occurrence of the noble crayfish (*Astacus astacus*).

The next three contributions were delivered by researchers from the Institute of Inland Fishery. Dr T. Krzywosz related the scope of a 2-year program for the protection of native crayfishes and his co-workers presented the following pa-

pers: "Pacifastacus leniusculus in Poland" (D. Ulikowski) and "Comparative analysis of the body proportions in *Orconectes limosus* and *Pacifastacus leniusculus*" (L. Chybowski).

During the break, participants, as should be expected of this community, were offered the noble and narrow-clawed crayfishes cooked in dill. Then M. Czarnecki from the Agricultural Academy in Poznan discussed *Orconectes limosus* in a food of sheatfish (*Silurus glanis* L.) and W. Struzynski characterized sexual activity of *Orconectes limosus* as an element of its expansion in Polish freshwaters. The next presentation by W. Struzynski and T. Niemiec from the Warsaw Agricultural University referred to effects of a 150 day breeding of *Astacus leptodactylus* hatching under controlled conditions and with the use of pelleted trout food.

Preliminary genetic analyses of crayfishes from Polish waters were presented by M. Soroka from the Agricultural Academy in Szczecin - the only feminine astacologist among the authors. Zdenek Duris, a good friend of mine from the University of Ostrava, Czech Republic, also attended the symposium. He compared the situation of crayfishes in Czech and Poland and suggested a regional co-operation in astacology between our research institutions. The only representative of potential crayfish farmers was A. Marczynski from Miastko, who specializes in salmon (*Salmo salar* L.) farming but has for years attempted to undertake crayfish production. He discussed plans for crayfish farming in his pond facilities. We wish him good luck in his plans.

Undertaking integrated research by particular research teams should be expected in the near future as an outcome of our symposium. I hope IAA will soon be joined by new members from Poland.

## NEWS FROM THE RUSSIAN ACADEMY OF SCIENCE

IAA member Valeri Fedotov sends the following information about recently completed crayfish research in Russia.

There are two diplomas both regarding the role of crayfish in water ecosystem completed recently by young researchers at the Laboratory of Experimental Ecology of Water Systems in St. Petersburg Scientific Center for Ecological Safety (Russian Academy of Science). Short summaries are provided below.

Study of crayfish introduction influencing on the processes of eutrophication in small fresh water bodies (Lake Beresno, Pskov Region of Russia as a case study).

Author: D. A. Zhuravlev

Supervisor: Dr. V. P. Fedotov

### Short summary

The process of eutrophication and the reasons for macrophyte growth in small fresh water bodies were considered. Ecological effect of crayfish on phosphorus cycling in fresh water ecosystem was discussed. Food consumption, turnover rates and assimilation in the crayfish *Astacus astacus* L. was considered.

The place of crayfish in trophic chain and its potential impact on primary production in Lake Berezno (Pskov Region) was investigated. Quantitative assessment for macrophyte production, its mass and area distribution and dynamic for last few years was made. Ecological effect of growing crayfish population as well as an artificial crayfish introduction on the process of eutrophication by macrophytes in Lake Berezno was examined. Designed project of crayfish farm for juvenile breeding was outlined.

Design for the experimental setup intended to determine the "critical" antropogenic impacts

on benthic invertebrates within the study of assimilative capacity of small water bodies.

Author: A. S. Kurakin (antoncat@mail.ru)

Supervisor: Dr. S. V. Kholodkevich  
(kholod@VF4493.spb.edu)

### Short summary

The concept of water body assimilative capacity was considered as the basis for ecological water management as well as some problems concerning its determination. Ecological role of benthic organisms was discussed as of possible ecological "targets" when assimilative capacity of water body is practically examined.

Advantages of non-invasive methods were underlined for recording the heart activity to evaluate the physiological response of benthic animals to chemical pollutants. To determine the "critical" concentrations influencing on benthic invertebrates, an experimental setup was designed and built for use with decapod and mollusks. To test developed experimental setup, it was applied to record changes in heart rate of crayfish *Astacus astacus* L., exposed to 0 - 60 mg/l copper ions in freshwater at 15°C.

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## KNOWLEDGE-BASED MANAGEMENT OF EUROPEAN NATIVE CRAYFISHES Dialogues between researchers

### & managers

IAA member Catherine Souty-Grosset sends the following update regarding preparations for the European crayfish meeting to be held in Poitiers, France, 13-15 September 2001. The second circular is still available (with both a provisional program and the re-



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gistration form) on the following website:  
<http://labo.univ-poitiers.fr/umr6556>

Some 90 crayfish workers from 18 countries responded positively to the First Circular, offering more than 30 oral communications and about 20 posters. In addition, many useful suggestions of topics for round table discussions were made. This is proof of the interest in promoting knowledge-based management of European native species.

We look forward to welcoming you to Poitiers, and anticipate that the scientific meeting will provide both the opportunity to address the urgent concerns of astacologists and a memorable experience.

**Aim of the meeting:** to bring together both researchers and managers to evaluate new findings, identify remaining research tasks and implement sound management policies and recommendations for conservation of the three European native species *Austropotamobius pallipes*, *Austropotamobius torrentium* and *Astacus astacus*. "Managers" may be crayfish farmers, fishermen or scientists monitoring and licensing fisheries, or those responsible for environmental quality or conservation at local, regional or national level.

**Meeting locations:**

**13 and 15 September:** Espace Mendès France (Poitiers town centre): all oral communications and poster sessions. Espace Mendès France the regional centre for science, technology and industry in Western France. The University is associated with project design and realisation. Every year 100 000 visitors discover Science and Technology through exhibitions, Planetarium, Science Theatre.

**14 September:** Pescalès, Moncoutant, Deux-Sèvres- excursion to the "Maison Internationale de la Pêche". There will be round-table

workshops morning and afternoon, a tour of the site after lunch, and the evening Banquet, before returning to Poitiers. The Pescalès site, 80 km from Poitiers, is a unique and recently created European Fishing Centre in the heart of Poitou-Charentes, near the Atlantic coast, Vendée and Maine et Loire: the site has more than 100 hectares of lakes and ponds and comprises a Discovery Zone with aquarium and educational nature activities.

**PROVISIONAL PROGRAMME**

**12 September 2001**

Espace Mendès France, Poitiers  
Registration and evening Welcome Drink.

**13 September 2001**

Espace Mendès France, Poitiers  
Registration  
Official Opening Ceremony  
Oral presentations Session 1:  
Present Knowledge  
Lunch Break and Poster session  
Session 2: Threats  
Town Hall reception  
Spectacle in planetarium of Espace Mendès France  
Free evening

**14 September 2001**

Pescalès (International House of Fishing), Moncoutant  
Welcome from the General Council of Deux-Sèvres  
Round table (2x2) discussions  
Lunch break  
Pescalès Site Tour  
Round tables (2x2)  
Banquet (regional gastronomy)

**15 September 2001**

Espace Mendès France (Poitiers)  
Session 3: Biological threats  
Session 4: Management strategies for native crayfish  
Lunch Break and Poster Session.

General Assembly: syntheses by the keynote speakers from each session and by rapporteurs for the round tables  
Farewell Drink

**PROCEEDINGS:**

Lectures by invited speakers and other contributors will be published in the Bulletin Français de la Pêche et de la Pisciculture (BFPP: Knowledge & management of aquatic heritage) after referees' assessment by the scientific committee. Manuscripts should be submitted to the Editor, E. Vigneux (contact: [esp.vigneux@ac-amiens.fr](mailto:esp.vigneux@ac-amiens.fr)) no later than mid January 2002. This volume will appear within 12 months after the Congress. Instructions to Authors will be given in the Abstract proceedings during the meeting and also on the website of the congress.

**Provisional titles of Round tables:** Out of 20 suggestions from registrants, we have identified 8 main themes for round table discussions. These will be held in pairs at Pescalès.

1A Monitoring, conservation and management of marginal populations  
1B Control and management of aliens

2A EU directives and conservation  
2B Interactions between native and aliens

3A Protection of natives in a plague situation  
3B Education as a key to conservation

4A Management: Reintroductions and restocking  
4B Management: Habitat restoration

**NEWS FROM LOUISIANA**

IAA General Manager **Jay Huner** sends the following update from Louisiana

The 2000-2001 Louisiana crawfish season is almost over. Some crawfish are coming in from the Atchafalaya Basin but almost all crawfish ponds are drained now. Average crawfish price for the 1999-2000 season was around \$1.25/pound - a record for the modern crawfish industry. Average crawfish price for the current 2000-2001 season will likely be closer to \$0.85 per pound, reflecting an increase in crawfish supplies even though the price represents the second highest average for any crawfish season.

Crawfish production in ponds was poor this season reflecting drought conditions carried over from the previous season and, likely, lingering effects of the rice pesticide Icon. There was "some" water in the Atchafalaya Basin for the 2000-2001 season compared to the previous season. As a result, crawfish were available from this source in modest amounts.

Crawfish meat and whole boiled crawfish - *Procambarus clarkii* - are now widely available in the USA from both the People's Republic of China and Spain. This "competition" has a dampening effect on Louisiana crawfish prices and is clearly responsible for the precipitous decline in the number of crawfish peeling plants operating in Louisiana - fewer than 10-15, down from the 75-80 operating a decade ago.

A plus from the availability of Atchafalaya Basin crawfish is the ability of farmers to stock crawfish in their ponds for the coming 2001-2002 season. Established crawfish ponds rarely have to be restocked with unharvested crawfish serving as brood stock for the coming season. However, crawfish are stocked into new ponds during the May-June period. This action is common when a rice-field is to be refilled with water in the autumn to serve as a crawfish pond.

## CRAYFISH POLY CULTURE STUDIES

IAA member **Glen Whisson** provides the following summary from six polyculture-related experiments conducted over a seven year period, 1992-1999.

*Experiments that formed the basis of this investigation:*

1. Density dependence of late 0+ marron. (183 days)
2. Interaction between juvenile marron and fingerling silver perch. (288 days)
3. Impact of polyculture on pond production and ecology. (655 days)
4. Interaction between marron, silver perch and an aquatic macrophyte. (267 days)
5. Evaluation of stocking density and grading on the performance of juvenile silver perch in cages. (408 days)
6. Polyculture of marron and silver perch in commercial grow-out ponds. (221 days)

Aquatic polyculture combines multiple species in the same culture system in an effort to maximise profitability through increased yields. Ideally, component species display complementary feeding behaviour, occupying distinct niches within the system. In situations where entirely compatible species cannot be used, or feeding niches overlap, polyculture can still produce commercial benefits through the manipulation of system-specific variables that directly impact on the nature and intensity of interactions.

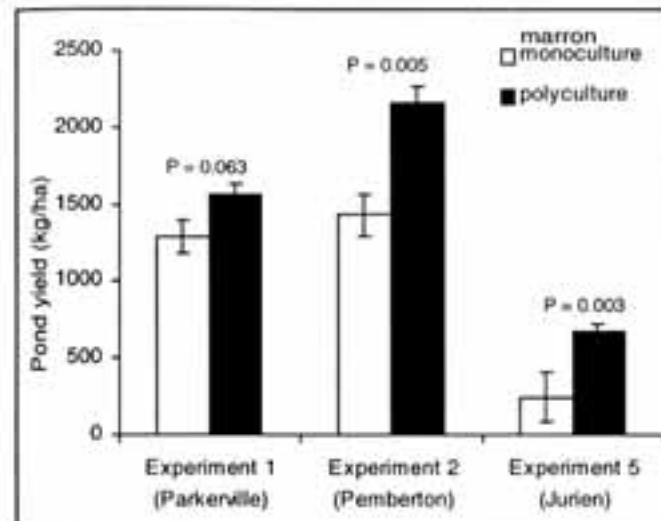
The polyculture system examined in this study combined a freshwater crayfish, marron (*Cherax tenuimanus*), with silver perch (*Bidyanus bidyanus*), a finfish native to the Murray-Darling Basin in eastern Australia. This research was undertaken to assist the marron aquaculture industry in Western Australia to diversify its income base while increasing pond yields with a secondary crop.

Trials were conducted in three culture systems (27m<sup>2</sup> tanks, 240m<sup>2</sup> experimental ponds, 1000m<sup>2</sup> commercial ponds), using three floating cage designs and a range of stocking sizes, densities and grow-out periods. A number of system and site-specific variables were identified that are likely to influence the commercial success of a marron-silver perch polyculture system. Within a free-range polyculture system these variables include: relative size of marron and silver perch at stocking; density of silver perch; marron gender and life stage; system turbidity; and habitat type/complexity.

Conditions conducive to predation, resulting in decreased marron production, include: small marron stocked with large perch; clear-water environments (i.e. low turbidity); a lack of suitable habitat/shelter complex; marron that have recently moulted; and a lack of alternative food sources.

The use of floating cages in polyculture allows crayfish full access to the benthos, without being directly impeded by the segregated finfish. Results clearly demonstrated that silver perch growth rates are reduced when confined in cages compared to free-range conditions. However, marron growth and survival was generally higher in systems with caged perch, displaying a synergism that resulted in higher yields from all pond-based production experiments (Figure 1). A plausible explanation of these higher yields in polyculture is a more efficient recycling process resulting in a re-distribution of food within the system.

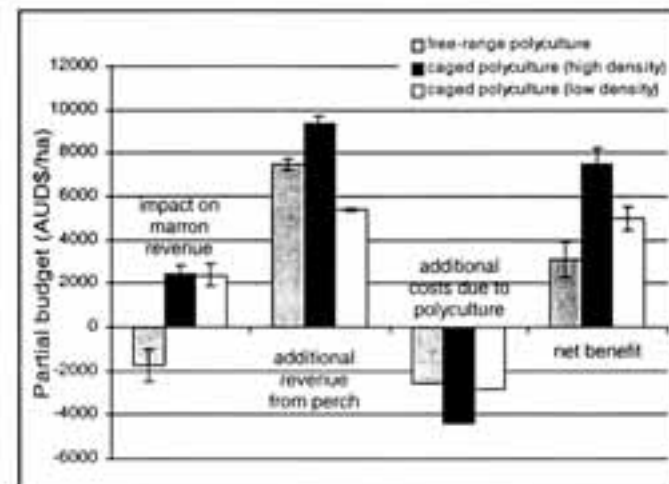
Polyculture treatments also displayed lower variability in all production experiments, indicating increased stability in the multi-species environment. Predation and competition are major structuring forces in multi-species communities and knowledge of



**Figure 1.** System yields from marron and silver perch production experiments: polyculture versus marron monoculture

**Figure 2.** Partial budget analysis of marron-silver perch polyculture versus marron monoculture

Values are the average of three treatment replicates ( $\pm$  SE)



predatory and competitive interactions helps the manager of a polyculture system manipulate the pond environment to minimise antagonistic relationships and maximise synergism.

Polyculture resulted in significantly higher net revenues in the commercial-scale trial. Figure 2 represents a partial budget analysis that compares the different polyculture strategies (i.e. free-range vs caged) with marron monoculture.

Polyculture ponds averaged AUD\$8,920/ha net gain compared to AUD\$3,745/ha for monoculture ponds.

Polyculture addresses economic risk on several fronts: diversification of product line (reduces exposure to market fluctuations); sharing of system resources and inputs (increases cost-effectiveness); and higher total yields (higher returns).

#### ADDRESS CHANGE

IAA member **David Holdich** has new contact details: 40 Brook View Drive, Keyworth, Nottingham NG12 5JN, UK.  
E-mail: david.holdich@ntlworld.com

#### UPDATE ON MARRON RESEARCH

IAA member **Craig Lawrence** (Fisheries Western Australia) provides the following update on the Fisheries Research and Development Corporation (FRDC) marron research project.

The FRDC marron research project has made significant progress since funding was approved 12 months ago. Over the past year, industry and researchers have worked together to convert an empty building and adjoining land at The University of Western Australia Shenton Park Agriculture Campus into one of the largest and best freshwater aquaculture research facilities in Australia. The facility has been constructed with funding provided by the Fisheries Research and Development Corporation, Aquaculture Development Council, The University of Western Australia, Fisheries Western Australia and industry.

The facility consists of thirty 20 tonne fibreglass tanks each 5 m in diameter, nine 7 tonne aquaplate ponds each 3 m in diameter, 144 x 100 L aquaria, a 66 m<sup>3</sup> biofilter and a 2400 m<sup>3</sup> reservoir. This provides an aquaculture research system capable of accommodating large-scale experiments with adequate replication. In addition the facility has laboratory space that can be temperature controlled, office space, workshop, a bore, and an electronic security system.

The research facility is currently being used for the FRDC Project 2000/215 "Improved performance of marron using genetic and pond management strategies". In this project the growth rate and size variation of six wild river strains, a domesticated strain, a mass

selected strain and industry stock are being compared in research ponds.

In addition, hybrids of the strains have been produced to determine if they have potential for aquaculture. Both the hybrid and strain evaluation experiments have been stocked and data is being recorded to identify the best performing marron for inclusion in our selective breeding program. Ponds are also being used to rear marron from different strains that have been individually tagged so that the effects of social interaction can be quantified.

In addition, the Shenton Park Laboratory has provided facilities for four postgraduate research projects. Two PhD projects (Leah Beesley and Patience Lindhjem), and two honours projects (Tessa Hewson and Matthew Ryan).

A major component of the FRDC marron research project is conducted on commercial marron farms. The commercial farm experiments have been established on four properties in Pinjarra, Pemberton, Mount Barker and Denmark. Two of the properties are being used for genetics experiments to compare the growth of a mass selected line of marron with a domesticated line and industry stocks. The other two farms are hosting husbandry experiments to quantify the effects of grading juveniles prior to stocking and the effect of increasing the density of hides upon both growth and size variation.

This collaborative research project between industry, university and Fisheries WA has resulted in the largest marron research program ever attempted in Australia. The current experiments are recording data from over 80,000 marron spread among commercial farms and the Shenton Park laboratory.

If you would like more information about this project please e-mail me at: <clawrence@fish.wa.gov.au>

#### ANDROGENIC GLAND IMPLANTATION INTO FEMALE CRAYFISH

IAA member **Amir Sagi** informs members that a recent paper on the induction of development of the masculine red patch and other male characters in female crayfish implanted with the androgenic gland has been published in the recent issue of *General and Comparative Endocrinology*. It merits announcement since a colour figure (a ventral view of a crayfish with a red patch) from this article was selected for the cover page of the issue. The Abstract is reprinted below:

The role of the androgenic gland (AG), an organ unique to male Crustacea, in the develop-

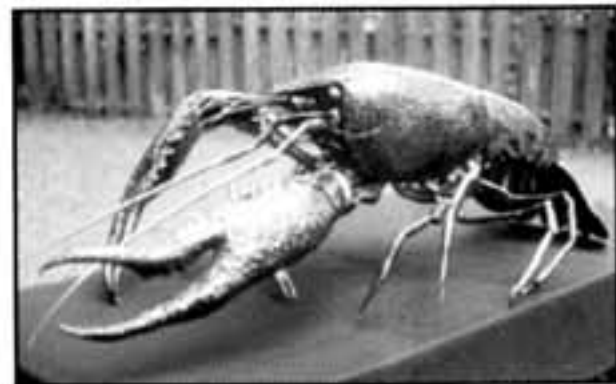
ment of sex characters and physiology of the reproductive system has not been fully documented in the red claw crayfish, *Cherax quadricarinatus*. To investigate the role of the AG in this species, the effect of implanting hypertrophied AGs into immature female animals was followed. Of the female animals with AG implants, 91.6% developed male-like propodi, including the red patch characteristic of males of this species.

The development of female secondary sex characteristics such as a wider abdomen, a wider endopod, and simple setation was inhibited. At the end of the experiment, the ovaries of the AG-implanted females contained mostly lipid-



"Crawfish 1" (above)  
Welded steel  
39"l x 28"w x 26"h

"Crawfish 3" (right)  
Welded steel  
60"l x 33"w x 18"h



#### STEEL CRAWFISH

Ed Barbier has sent pictures of his crayfish creations. Magnificent steel sculptures that are available for sale. Commissions for other work are accepted.

If you would like more information please contact Ed:

Email: edbarbier@earthlink.net; or visit his homepage:

<http://home.earthlink.net/~edbarbier>