

and Ca<sup>2+</sup> release from internal stores for concentration. *J Exp Biol* 181:95-106.

Whitley, N.M. & E.W. Taylor. 1993. The effects of seasonal variations in temperature on extracellular acid base status in a wild population of the crayfish *Austropotamobius pallipes*. *J Exp Biol* 181:295-312.

Wright, D. A. & P. M. Welbourn. 1993. Effects of mercury exposure on ionic regulation in the crayfish *Orconectes propinquus*. *Environmental Pollution* 82:139-142.

#### New Members

Aurum Aquaculture Ltd. - Charles A. Mitchell - Rt. 1, Box 1 H, Hwy 82 at Old Hwy 61, Leland, Mississippi 38756-9601 USA. Phone (800 USA) 817-5808 or (601) 686-9002, Fax (601) 686-9020. This is a business membership. Aurum Aquaculture, Ltd. is a supplier of chemicals, aquaculture equipment, drugs, and books. A catalog of products will be supplied upon request.

Boldyreff, Roman E. - 10350 Bowman Avenue, Pensacola, Florida 32434 USA.

Conklin, Douglas E. - Department of Animal Science, University of California, Davis, California 95616-8521 USA.

Kenswed Ltd. - Mohammad Ishfaq Chaudry - P. O. Box 10498, Nairobi, Kenya. Phone 569227 and Fax 568077. This is a business membership. Kenswed Ltd is a dealer in freshwater crayfish.

Novoseltsev, G. - Laboratory of Hydrobiology, Sevribnirh, 185650, Petrozavodsk, Varcous 3, Karelia, Russia.

Peeke, Harman V. S. - Brain-Behavior Research Center, Department of Psychiatry, University of California, Sonoma Developmental Ctr Ctr, Eldridge, California 95431 USA.

Pozeraite, Ramune - Virsuliskiu 83-52, 2056 Vilnius, Lithuania.

Pujadas, Alejandro de Diego - Apdo 150.020, E-28080 Madrid, Spain.

Watts, Stephen A. - Department of Biology, University of Alabama at Birmingham, Birmingham, Alabama 35294-1170 USA.

#### New Addresses

Blake, Michael - Department of Zoology, University College Cork, Ireland, Lee Maltings, Prospect Row, Cork, Ireland.

Buchanan, James - 6617 Grelot Road, Apartment H6, Mobile, Alabama 36695 USA.

Forbes, Alec - 6964 NW 50th Street, Suite #PM-100, Miami, Florida 33166-5632 USA.

Hamr, Premek - 532 Jeanette Drive, Oakville, Ontario, Canada L6K 1N1.

Harris, Mary Ellen - 1121 Via Nice, Redlands, California 92374 USA.

Herbert, Brett W. - Freshw Fisheries and Aquaculture Centre, Research Station, Kennedy Highway, Walkamin, Queensland 4872 Australia.

Jussila, Jappo - Department of Applied Zoology, University of Kuopio, P.O.B. 16127, SF-70211 Kuopio, Finland.

Machin, Dan-Zool Dept. Lee Maltings, Univ College Cork, Cork, Ireland.

Nature and Crayfish Projeet, Sorovej 92, DK-4200 Slagelse, Denmark.

Pagel, Robert-117 W. Washburn Rd, Deerfield, Wisconsin 53531 USA.

Saffron, Karen A. - 2023 Ulster Road, N.W., Number 75, Calgary, Alberta, Canada T2N 4C4.



# Crayfish NEWS

## IAA Newsletter

Volume 15 Number 3 October 1993

### IAA

*The International Association of Astacology (IAA), founded in Hintersal, Austria in 1972, is dedicated to the study, conservation, and wise utilization 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.*

#### Secretariat

*The International Association of Astacology have a permanent secretariat. The Secretariat is managed by Jay Huner and the address is IAA Secretariat, P.O. Box 44 650, Univ. of Southwestern Louisiana, Lafayette, Louisiana 70504, USA; phone (318) 231-5239 / fax (318) 231-5395.*

#### Officers:

*Jay Huner, President, Crayfish Center, Univ. Southwestern Louisiana, Lafayette, Louisiana 70504, USA.*

*Jostein Skurdal, President-Elect, Eastern Norway Research Inst., P.O. Box 1066 Skurva, N-2601 Lillehammer, Norway.*

*Paula Henttonen, Sec/Treas., Dept. Appl. Zoology, Univ. Kuopio, P.O. Box 1627, SF-70211 Kuopio, Finland.*

*David Holdich, Past - President, Dept. of Life Science., Univ. of Nottingham, Nottingham NG7 2RD, England.*

#### IAA News

##### 1. Semen Brodsky's Book on Crayfish in the Ukraine

Professor Brodsky's book has been translated into English. Those who have seen the original recognize that this translation will be an excellent contribution to the Astacological Literature providing information that would otherwise be unavailable outside of his native country. Professor Brodsky writes that in order to publish the book at the end of 1993-beginning of 1994, it is necessary to sell 50-60% of the 500 copies at \$US 50 to cover expenses. The IAA Board has endorsed Professor Brodsky's book and encourages members to support it by buying copies. Contact: Professor Semen Ya. Brodsky, Ramot-A Block 34/3 Sullam Yaakov Street, 97729 Jerusalem, Israel. Tel. 02.868381.

##### 2. Freshwater Crayfish IX is now available.

The contents of FC IX were published in the last newsletter. The efforts of the editors, David Holdich and George Warner, are much appreciated. Copies are being sent to all paid participants of the Reading meeting. Others may order copies from the Secretariat - P.O. Box 44650, University of Southwestern Louisiana, Lafayette, Louisiana 70504 USA. Cost is \$US 25 per copy. Postage and handling charges are: USA and Canada - \$US 3; Overseas Surface - \$US 4; and Overseas, Small Package Air Mail - \$US 14. IAA cannot accept credit card payments. All checks must be official bank checks with routing code numbers on the bottom margins and drawn on a US bank.

##### 3. Freshwater Crayfish VIII

Editor Robert Romaine (School of Forestry, Wildlife & Fisheries, Louisiana State University, Baton Rouge, Louisiana 70803 USA) informs the Secretariat that FC VIII has been sent to the copy editor and may be published before the end of the year.

##### 4. Secretariat will distribute FC IV

Professor Pierre Laurent, past IAA president, Life Member, and editor of FC IV, is transferring the remaining copies of FC IV to the Secretariat for storage and sales.

##### 5. Physiology and Adaptation in Crayfish

This IAA sponsored symposium will be held on 28

December 1993 in conjunction with the annual American Society of Zoologists meeting in Los Angeles, California USA at the Los Angeles Hilton and Towers Hotel. It is organized by IAA members Brian McMahon (Dept. of Biological Sciences, University of Calgary, Calgary, Alberta, Canada T2N 1N4) and Milton Fingerman (Dept. of Ecology, Evolution and Organismal Biology, Tulane University, New Orleans, Louisiana 70118 USA). Symposium co-sponsor is The Crustacean Society. IAA acknowledges with much appreciation a contribution of \$500 made by the Crustacean Soc. toward the expenses incurred in organizing the meeting.

#### 6. Progress Report on IAA X Adelaide 1994

This topic was discussed at length in the last newsletter. Registration materials were mailed to all members in August of this year. Pre-registrations now approach 100 with all continents represented.

For more information contact: Mike Geddes, IAA X Symposium Organizer, Department of Zoology, GPO Box 498, University of Adelaide, Adelaide, South Australia 5001, Australia. fax 61 8 223 5817; tel 61 8 228 5934. Important note: make certain that you secure travel Visa's well in advance of your departure!!

#### IAA Correspondents

IAA Correspondents include: Jorma Kirjavainen, Finland; Gunter Vogt, Germany; John Foster, Great Britain; Trond Taugbøl, Norway; Alexandra Correia, Portugal; Javier Dieguez-Urbeondo, Spain; Tommy Odelström, Sweden; and Patrick Bagot, Turkey. Anyone interested in volunteering to become an IAA Correspondent should contact the Secretariat.

#### Crayfish Production/Utilization Notes

##### 1. Sweden

Past President Stellan Karlsson (Simontorp, S-270 35 Blentarps, Sweden) writes that Swedish production of crayfish may be around 600 tonnes for 1993. He says that there has been a weakening of price.

Information from the U.S. Embassy in Stockholm (Report to Roy L. Johnson, LDAF-Marketing, Baton Rouge, LA from Thomas A. Hamby, Agricultural Councillor, 9/13/93) shows crayfish imports in 1992 as follows: Total - 2,105, USA - 1,937; People's Rep. China - 59; Costa Rica - 50; Spain - 17; Russia - 11; and Canada - 9. Total value was 93,795,000 SEK.

##### 2. France

Past President Pierre Laurent (Avonnex a Marin, F-74200 Thonon, France) reports that 122.5 tonnes of

frozen and 268.1 tonnes of live crayfish were imported into France during 1992. Spain provided 92 % of the frozen crayfish with very small amounts coming from Turkey, USA, Great Britain, and the People's Rep. of China. Turkey provided 81% of the live product. Modest amounts of live crayfish were imported from Spain, Italy, Greece, Yugoslavia, and the USA.

##### 3. People's Republic of China

A reliable source reports that 204 metric tonnes of crayfish meat was exported from China in 1992. There are companies processing tail meat (*Procambarus clarkii*) in Hubei, Jiangsu, Jiangxi, Shanghai, and Zhejiang Provinces.

##### 4. Hungary

Member Miklos Thuranszky (25 Belgrad Rep., H-1056 Budapest, Hungary) reports that at least 10 metric tonnes of *Astacus leptodactylus* is harvested from one reservoir for export to western Europe. Size limit is 10 cm.

##### 5. USA - Louisiana

This is the season that will not end! The summer floods in the upper Mississippi River Valley have not damaged property in Louisiana. However, the high water has kept the overflow swamp systems, especially the Atchafalaya System, flooded and crayfish from the 1992-93 "season" are still being harvested. It is not clear what this will mean for the 1993-94 season. Normally, the swamps dry completely in the summer. Historically, however, the season following one like the 1992-93 season is usually "good" but not "great." No data are available yet on production in ponds and in natural systems for 1992-93. [Source: Jay Huner]

#### Soybeans and Corn for Crayfish Feeds

Member Doyle Schaer (P.O. Box 307, Danevang, Texas 77432 USA) applied 8,273 kg of a 70%/30% soybean/corn mixture to a 24.3 ha crayfish pond on May 22, 1993. According to Mr. Schaer, catch fell from 545 kg per daily run to 167 kg for 12 days. On the twelfth day he caught 455 kg of exceptionally high quality crayfish - *Procambarus* spp. There were no water quality problems associated with the application of the "feed." While Mr. Schaer was pleased with the results, he has many questions about feeding strategies, costs, other grains, etc.

#### World Aquaculture Society Meeting

The 25th anniversary meeting of the World Aquaculture Society will be held in conjunction with

the Aquaculture Expo VII 12-18 January 1994. Venue is New Orleans, Louisiana USA at the New Orleans Marriott Hotel. This is a meeting that anyone seriously interested in crayfish aquaculture should attend. More information may be obtained from Bill Glasscock, Aquaculture Productions, Inc., P.O. Box 24866, Little Rock, Arkansas 72221 USA. Phone (800/USA) 467-3350 or (501) 225-6102. Fax (501) 223-8230.

#### Indians Request Information on Crayfish

Mullapudi Narendra Nath represents the Tanuku Veterinary Institution Development Society (Old Town, Tanuku 534 211 A. P., India). Dr. Nath says that TVIDS is a farmer's organization seeking information on cultured freshwater crayfishes for its library. Members are encouraged to send materials to Dr. Nath.

#### Journal Exchange Initiated

Dr. Herbert Zobel is editor of Fischer & Teichwirt, a German aquacultural magazine. Dr. Zobel contacted IAA because of growing interest in cultivating *Cherax quadricarinatus* in Germany. IAA is now exchanging our newsletter with Dr. Zobel. (Fischer & Teichwirt, Deutscher Bauernverlag GmbH, Reinhardstr. 14, O-1040 Berlin, Germany.)

#### Crayfish in Russian Karelia

Member Dr. G. Novoseltsev (Laboratory of Hydrobiology and Aquaculture, 185650, Petrozavodsk, Varcaus 3, Karelia, Russia) sends news about crayfish work in Russian Karelia for the past five years. The goal is to develop a firm understanding of the biology and ecology of the endemic species *Astacus astacus* and *Astacus leptodactylus*. Dr. Novoseltsev has been pleased with progress in his group's studies of the distribution, structure, and composition of natural crayfish populations in northern lakes. However, development of methods to produce crayfish hatchlings have not been progressing as rapidly as desired. Dr. Novoseltsev believes that his group's work would benefit through greater international contacts and exchange of publications. We encourage members to correspond with Dr. Novoseltsev.

#### On Crayfish Catching in Estonia

Jaanus Tuusti (Forest Research Institute, EE2400 Roomu tee 2, Tartu, Estonia) prepared the following report about crayfish catching in Estonia. The figure and map he sent could not be duplicated here and members should request these from him.

Yearly accounts of catching permits have served as the basis for assessment of the condition of crayfish populations. The uniform order of catching crayfish and the permit system allow consolidation of the results and assessment of the distribution and changes in crayfish populations and reproductive activities. Crayfish nets are used to catch the crayfish. It is possible to calculate the number of harvestable crayfish caught per net-hour as a measure of productivity of a habitat. The best crayfish waters have catch rates of 50 crayfish per net-hour. These are, however, exceptions. The mean productivity on the mainland is 1-2 crayfish per net-hour and on the island of Saaremaa it is 3-4 crayfish per net-hour.

Protection of crayfish resources has been the basis of working out crayfish catching licenses. The number of permits issued has been considerably smaller than the crayfish resources would allow. It is due to abusive fishing methods. The number of permits has been corrected annually according to the harvest in previous years. The number and list of water bodies where hobby catching is permitted has been changed continuously. At present, more than 130 rivers and 135 lakes have been registered as crayfish habitats. Of this number about 10 lakes and 10 rivers on the mainland and 8 lakes on Saaremaa are classified as "good" crayfish water bodies. The remaining crayfish populations are satisfactory or poor from the point of view of production. Crayfish harvest records for the past 13 years show that the peak was reached in 1983 with 30,000 legal crayfish harvested. During the next two years, the situation changed drastically due to the death of crayfish populations in 15 mainland water bodies. Crayfish deaths occurred in Kaave, Reiu, Lannemetsa, Nurtu, Paardu, Nova, Vihterpalu, Kloostri, Angerja, Enge, Vivda Rivers and other water bodies. Crayfish in Kaave River and Lannemetsa Brook died due to pollution. The crayfish were lost because of dredging. It is possible that crayfish plague occurred in some water bodies as well. The populations have not been restored in the referenced water bodies.

One-third of the total catch comes from Saaremaa's waters. The numbers of legal-sized crayfish fell drastically there in 1984-1985. As a result, crayfishing was prohibited in 1985. The crayfish plague has not occurred at Saaremaa and the fungus spot disease - widespread on the mainland - does not occur there. Thus, Saaremaa is very valuable as a source of stocking material for repopulating water bodies on the mainland with crayfish.



#### Crayfish Waste and Small Crayfish

Roughly 85% of whole crayfish is "wasted" when they are peeled for meat only. This waste material is a very real resource but, at best, serves only as a soil enrichment factor in Louisiana where at least 20-30,000 tonnes of "waste" is generated annually. Furthermore, there is much crayfish that cannot be harvested because they are too "small" to be processed by hand peelers - size 8-18 g.

Considerable research has been conducted at the Louisiana State University Department of Food Sciences (Baton Rouge, Louisiana 70803 USA) on methods to utilize the wastes. Significant contributions have been made by Drs. Sam Meyers, James Rutledge, Michael Moody, and Keith Cadwallader. Drs. Meyers and Rutledge did much of the research that led to the establishment of a commercial plant producing crayfish meal and astaxanthin enriched oil. Now, Dr. Cadwallader has been developing methods to extract "flavor" from crayfish wastes. He reports very encouraging preliminary results and has developed a protocol for industrial production of flavors for such things as bases, attractants, etc.

An offshoot of Dr. Cadwallader's work involves use of a meat/bone separator to "grind" the raw material. This produces "shell" and edible "paste." While the two components are combined for extraction of flavor, it is clear that this technology has the possibilities of producing large quantities of edible "paste" when crayfish that are too small for conventional processing (by hand) are used rather than peeled crayfish wastes. This is a subject that your president is pursuing as a project related to his work at the University of Southwestern Louisiana's Crawfish Research Center.

#### News from Canada

Member Premek Hamr (532 Jeanette Drive, Oakville, Ontario, L6K 1N1 Canada) sends the following news: Since my return to Canada (from Tasmania, in 1992), I have been working with the Canadian Wildlife Service and over the past summer I have had a chance to make some interesting observations of the distribution and life history of the two burrowing crayfish species in southern Ontario (*Fallicambarus fodiens* and *Cambarus diogenes*). I have observed copulation in captivity for *F. fodiens* (in mid June) and I believe I have also found the new "most northern" record for this species at Wye Marsh, near Midland, Ontario, on the southern shore of Georgian Bay. I have also found a new locality record for *C. diogenes* on Long Point (Lake Erie), Ontario. This species has an extremely

restricted distribution in Canada as it apparently only occurs on Point Pelee and Long Point, two southern peninsulas on Lake Erie. I believe that my record of this species is the first one since Croker & Barr's surveys of the mid 1960s!

#### Request for Unusual Biological Film

Max Von Schuler (Office KEI, Inc., 110 East 42nd Street, Suite 1419, New York, New York 10017 USA) is currently producing "Super Camera." His firm is looking for unique footage never before seen by the human eye. These areas include the cutting edge of camera technology, footage that is dangerous to shoot, such as in volcanos or underwater, and events from both the natural and physical science worlds. The firm is especially concerned with films showing unusual habits of fish such as nesting, mating, fighting, etc.

#### Crayfish Ecology Studies in SE Texas

Member David Bechler (Dept. of Biology, Lamar University, Beaumont, Texas 77710 USA) has been studying the interactions of the white river crayfish, *Procambarus zonangulus*, and the red swamp crayfish, *Procambarus clarkii*, in forested wetland areas in southeastern Texas. While the red swamp crayfish is more fecund, the male white river crayfish is heavier and has longer chelipeds. Both species coexist in the same water bodies and Dr. Bechler's data are helping to explain their interactions. A manuscript summarizing Dr. Bechler's work (with the late Xuehuai Deng and Kwan Lee) will be published shortly by the Journal of Shellfish Research.

#### El Cangrejo de Rio en Leon [Spain]

This small but information packed crayfish book is published in Spanish and deals with the crayfishes of the Leon region of Spain. Authors are V. R. Gaudioso, J. D. Celada, J. Carral, and P. L. Rodriguez. Publisher is Universidad de Leon, Servicio de Publicaciones, Leon, Spain. ISBN: 84-7719-033-X. It is a very worthwhile publication and the illustrations, especially the color plates of embryonic development, are very useful.

#### Crayfish of New South Wales [Australia]

This is another small but information packed crayfish book published in English and deals with the crayfishes of the Australian state of New South Wales. Author is John R. Merrick. Publisher is the Linnean Society of New South Wales (P.O. Box 457, Milson's Point, New South Wales 2061

Australia). ISBN 0 9590535 1 4. This, too, is a very worthwhile publication. Readers will find the color plates of various Australian crayfish species to be especially interesting showing the morphological and colorful variations in body forms unlike those observed in other crayfish faunas around the world.

#### *Procambarus clarkii* on the Azores

Member and IAA correspondent Alexandra Correia (LaSonorio Antropologico e Zoologico, Museu Bocage, R. Escola Politecnica 58, 1200 Lisboa, Portugal) informs us that *P. clarkii* has been successfully introduced in one reservoir in the Azores.

#### *Procambarus clarkii* in South Africa

Member H. J. Schoonbee (Research Unit for Aquatic and Terrestrial Ecosystems, Dept. of Zoology, Rand Afrikaans University, P.O. Box 524, Auckland Park 2006, Republic of South Africa) has sent the following reprint: Schoonbee, H. J. 1993. Occurrence of the red swamp crayfish *Procambarus clarkii* (Crustacea: Cambaridae) in the Crocodile River at Dullstroom, Transvaal [Republic of South Africa]. Water SA 19(2):163-166.

The brief abstract states that: The red swamp crayfish *Procambarus clarkii* (Girard) has been found in the sponge area of the headwaters of the Crocodile River in the Transvaal. Indications are that it occurs in relatively low numbers despite potentially favourable environmental conditions. Predators such as otters may play a role in its control. The danger exists that it may spread further downstream with time or be translocated to other localities by anglers visiting the site.

#### *Procambarus clarkii* documented in Italy

In the most recent issue of L'Astaciculteur de France it is confirmed that there are wild populations of *Procambarus clarkii* in Italy.

#### Crawfish Research Projects Summarized

Member Ray McClain (P.O. Box 1429, Rice Research Station, Crowley, Louisiana 70527 USA) has published an "Annual Summary and Reports 1991-1992 - Crawfish Research Project." Topics include: Annual Summary of Environmental Conditions and Crawfish Production; Evaluation of sorghum-sudangrass hybrid as a crawfish forage crop; Effects of supplemental feed on crawfish production; Effects of forage type and supplemental feed on crawfish growth; Effects of population density on crawfish growth; and Effects of relaying

crawfish into commercial rice fields planted in typical and non-typical seedbeds.

#### *Psorospermium* Update

*Psorospermium* occurs in all crayfish families and has been known since the mid-1800s. Yet, it has yet to be definitively identified with respect to taxon! Member Kenneth Söderhäll (Dept. of Physiological Botany, University of Uppsala, S-751 21 Uppsala, Sweden) has initiated molecular biological studies of *Psorospermium* DNA to resolve the mystery of the organisms taxonomic position!

#### Crayfish research in Norway

Member and IAA correspondent Trond Taugbøl (Eastern Norway Research Institute, POBox 1066 Skurva, N-2601 Lillehammer, Norway) has sent the following information on crayfish studies and situation in Norway: In Norway the first outbreak of crayfish plague was reported in 1971 in the connected rivers of Veksa and Vrangselva, a river system draining to Sweden. The disease spread upstream from Sweden. The last plague-infected crayfish was diagnosed here in 1974. In 1987 the crayfish plague suddenly reappeared in Norway - this time in the River Glomma, the largest river in Norway. In 1989, two other watersheds became infected - the Lake Store Le (mostly located Sweden) and the Halden lake/river system. Probably, the disease was brought into our country from Sweden. In 1987 there was a plague outbreak in Sweden within a distance of two-three hours of driving. However, this is only speculations.

Many tributaries to the River Glomma and to the Halden lake/river system have not been hit by the plague. This is believed to be due to barriers (weirs, waterfalls) or stretches empty of crayfish (due to inferior water quality) which make it impossible for the crayfish itself to spread the plague by upstream migration. The plague-affected area in Norway is delineated by detecting live and healthy crayfish in neighbouring localities and by using test cages with live crayfish.

The crayfish plague fungus does not appear to have any vectors or secondary hosts, there are no resting structures, and the spores have a very limited viability outside the crayfish host. Therefore, it should be a great possibility for self-eradication of the crayfish plague from infected watersheds and subsequent restoring of the crayfish populations.

To test whether the crayfish plague is still present, cages with live crayfish has been placed out in the infected waters since 1988. Since October 1990,

no plague-infected crayfish has been detected, neither in cages nor free-living, indicating that the disease may be eliminated from Norwegian waters.

In the light of the cage experiments, Norwegian authorities decided to start restocking of crayfish in River Glomma in autumn 1989. In 1989-1991 a total of 3,843 adult crayfish (> 90 mm total length) has been stocked at a specific site. The crayfish were stocked concentrated within a small area to make it easier for the crayfish to locate each other during the approaching mating period. The stocking site has been surveyed yearly by SCUBA-diving. Until 1993, only recaptures of stocked crayfish was found. In September 1993 the first recruits were found with a size up to 60 mm TL, indicating successful reproduction and that the population is building up. It will be very exciting in the years to come to follow the development of the population.

In 1992 we also started restoring of the plague affected L. Vingersjøen, which is connected to river Glomma. A total of 1,800 crayfish was stocked in 1992 and 1993.

A good crayfish population has since long been re-established in the plague affected Lake Nessjøen in the Veksa/Vrangselsva watershed (crayfish plague in 1971-74), most likely due to restocking by local fishermen. L. Nessjøen is an excellent example showing the possibility of restoring the native crayfish population after a plague attack. Crayfish have also returned in the River Vrangselsva due to restocking, but only in some parts of the river and at a very low density. Inferior water quality due to pollution is probably the reason for the low density.

The results from the cage experiments in the Halden watershed are also very promising, and provided no plague attacks, restocking here will probably be initiated in 1994.

The Eastern Norway Research Institute has recently started a project on restoration of crayfish populations in formerly polluted waters, financed by the Norwegian Research Council and the Directorate for Nature Management. Numerous crayfish populations in Norway have been eradicated by pollution. Following an extensive construction of wastewater treatment plants and better control of agricultural pollutants, many formerly polluted waters have no viable conditions for crayfish. In our project we have selected such localities and do practical stocking experiments in order to re-establish the crayfish population. We want to investigate different stocking procedures and post-stocking movement as well as more general aspects of population dynamics. In a channelized river we want to carry

out habitat improvements and evaluate the effects of different improvement structures on the crayfish population.

#### Publications of Interest to Astacologists

Aiken, D. E. & S. L. Waddy. 1992. The growth process in crayfish. *Reviews in Aquatic Sciences* 6(3,4):335-381.

Anderson, A. C. & J. C. Rice. 1993. Survey of fish and shellfish consumption by residents of the greater New Orleans area. *Bull. Environ. Contam. Toxicol.* 51:508-514.

Blakewood, E. G., C. L. Burras, & J. V. Huner. 1993. The effect of hydrological parameters on the burrowing ability of the red swamp crayfish. Newsletter of the Louisiana Crawfish Farmers Association, August 1993, page 2.

Chen, S., K. A. Rusch, & R. A. Malone. 1993. Use of electrical stimulation in the automatic separation of soft-shell crayfish. *Progressive Fish-Culturist* 55:114-120.

Collins, R. O., L. M. Goodwin, & T. G. McRae. 1993. A practical system for counting yabby hatchlings. *Yabby Growers Association of Australia, Yabby Tales* 4(6):14-16.

Correia, A. M. 1992. A note on the occurrence of white-eyed red swamp crayfish, *Procambarus clarkii* (Decapoda: Cambaridae) in Portugal. *Arquivos do Museu Bocage, nova serie, V. II, No 11*:257-261.

Correia, A. M. 1993. Situation de l'acclimatation de l'ecrevisse rouge des marais *Procambarus clarkii* au Portugal. [Status of the introduction of red swamp crayfish (*Procambarus clarkii*) in Portugal. *L'Astaciculteur de France* 35:2-9.

Curtis, M., C. Jones, & P. Long. 1993. Flow trapping redclaw. *Yabby Growers Association of Australia, Yabby Tales* 4(6):9-11.

Duvic, B. & K. Söderhäll. 1993. B-1,3-glucan-binding proteins from plasma of the freshwater crayfishes *Astacus astacus* and *Procambarus clarkii* *J. Crustacean Biol* 13(3):403-408.

Fraser, K. & W.J. Heitler. 1993. Anatomical and physiological identification of inhibitors of the motor giant and segmental giant neurons in the crayfish. *J. Exp. Biol.* 180:55-74.

Geddes, M.C. & M. Smallridge. 1993. Survival, growth and yield of the Australian freshwater crayfish *Cherax destructor* in extensive aquaculture ponds. *Aquaculture* 114(1-2):51-70.

Hamano, T., K. Hayashi, T. Kawai, & H. Hayashi. 1992. Crayfish (Crustacea, Decapoda) in Lake Mashu, Hokkaido. *Researches on Crustacean, Carcinological Society of Japan*. 21:73-87.

Heitler, W.J. & K. Fraser. 1993. Thoracic connections between crayfish giant fibres and motor giant neurones reverse abdominal pattern. *J. Exp. Biol* 181:329-

Huner, J. V. 1993. The economics of crawfish, rice, and birds in Louisiana and Texas fields. Presented at the First Annual AgroEcology Conference, University of Southwestern Louisiana, Lafayette, Louisiana USA, 4 pp. mimeo.

Huner, J. V., C. Wiggins, S. Chen, & R. Malone. 1993. Practical application of bilateral eyestalk ablation for production of soft-shell red swamp crayfish and white river crayfish. *Proc. Louisiana Aquacult Conf, Louisiana State Univ Agricultural Center, Baton Rouge, Louisiana USA*:31-33.

Kawai, T. 1993. Incidence of blue color phase of *Cambaroides japonicus*. *Bull. Higashi Taisetsu Museum of Natural History* 15:73-76.

Kawai, T. 1993. Natural history and northern limit distribution of Japanese crayfish *Cambaroides japonicus*. *Nature and Animals of Hokkaido* 7:61-64.

Kawai, T. 1992. Burrow of a Japanese crayfish *Cambaroides japonicus* (De Haan, 1841). *Res on Crustacea, Carcinological Soc of Japan* 21:65-71.

Kawai, T. 1992. External changes associated with molting in aquaria in *Cambaroides japonicus* (De Haan, 1841) (Astacoidea, Decapoda). *Res on Crustacea* 21:89-95.

Khoury, G. A., A.A. Abdelghani, & A.C. Anderson. 1993. Bioaccumulation and depuration of ethylene glycol by crayfish (*Procambarus* spp.). *J. Environ. Toxicol. Water Qual.* 8:25-31.

King, C. 1993. Potential fecundity of redclaw crayfish, *Cherax quadricarinatus* von Martens, in culture. *Aquaculture* 114:237-241.

Kopacek, P., M. Hall, & K. Söderhäll. 1993. Characterization of a clotting protein, isolated from plasma of the freshwater crayfish *Pacifastacus leniusculus*. *Eur. J. Biochem.* 213:591-597.

Lamontagne, S. & J. B. Rasmussen. 1992. Estimating crayfish density in lakes using quadrats: maximizing precision and efficiency. *Can. J. Fish. Aquat. Sci.* 50:623-626.

Laurent, P. J. 1993. Les importations d'ecrevisses en France en 1992. *L'Astaciculteur de France* 35:11-16.

Liang, Z., P. Lindblad, A. Beauvais, M. W. Johansson, J. Latge, M. Hall, L. Cerenius, & K. Söderhäll. 1992. Crayfish alpha macroglobulin and 76 kDa protein; their biosynthesis and subcellular localization of the 76kDa protein. *J. Insect Physiol.* 38:987-995.

Mather, M.E. & R.A. Stein. 1993. Using growth/mortality trade-offs to explore a crayfish species

replacement in stream riffles and pools. *Can. J. Fish. Aquat. Sci.* 50:88-96.

Mather, M.E. & R.A. Stein. 1993. Direct and indirect effects of fish predation on the replacement of a native crayfish by an invading congener. *Can. J. Fish. Aquat. Sci.* 50(6):1279-1288.

Momot, W. T. 1992. Further range extensions of the crayfish *Orconectes rusticus* in the Lake Superior Basin of Northwestern Ontario. *Canadian Field-Naturalist* 106:397-399.

Naqvi, S. M. & R. D. Howell. 1993. Cadmium and lead uptake by red swamp crayfish (*Procambarus clarkii*) of Louisiana. *Bull. Environ. Contam. Toxicol.* 51:296-302.

Naqvi, S. M. & R. D. Howell. 1993. Toxicity of Cadmium and lead to juvenile red swamp crayfish, *Procambarus clarkii*, and effects on fecundity of adults. *Bull. Environ. Contam. Toxicol.* 51:303-308.

Naqvi, S. M., R. D. Howell, & M. Sholas. 1993. Cadmium and lead residues in field-collected red swamp crayfish (*Procambarus clarkii*) and uptake by alligator weed, *Alternanthera philoxeroides*. *J. Environ. Sci. Health B28(4)*:473-485.

O'Brien, B. and G. Whisson. 1993. Relative growth of flyers and runts. *Marron Growers Association Bulletin* 15(1):6-8.

O'Donoghue, P. 1993. Microsporidian parasites of freshwater crayfish. *Yabby Growers Association of Australia, Yabby Tales* 4(6):12-13.

Ranta, E. & K. Lindström. 1993. Body size and shelter possession in mature signal crayfish, *Pacifastacus leniusculus*. *Ann. Zool. Fennici* 30:125-132.

Roell, M. J. & D. J. Orth. 1993. Trophic basis of production of stream-dwelling smallmouth bass, rock bass, and flathead catfish in relation to invertebrate bait harvest. *Trans. Am. Fish. Soc.* 122:46-62.

Salvidio, S., P. Cresta, & G. Doria. 1993. Preliminary survey on the distribution of the freshwater crayfish *Austropotamobius pallipes* in Liguria, NW Italy. *Crustaceana* 65(2):218-221.

Somers, K.M. & R.H. Green. 1993. Seasonal patterns in trap catches of the crayfish *Camarus bartoni* and *Orconectes virilis* in 6 south-central Ontario lakes. *Can J Zool* 71(6):1136-1145.

Söderhäll, K. & A. Aspan. no date. Chapter 9, Prophenoloxidase Activating System and Its Role in Cellular Communication. in pp. 113-129. J. P. N. Pathak (ed.) *Insect Immunity*. Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi, Bombay, Calcutta.

Ushio, H., S. Watabe & Miino. 1993. Crayfish skeletal muscle requires both influx of external Ca<sup>2+</sup>