Crayfish News

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Major Fires Affecting Crayfish in Tasmania

Figure 1. *Ombrastacoides denisoni*, a critically endangered species: over 40% of its range was burned this summer.

Inside this issue

Fire is a natural factor in the ecology of Tasmania, but as the climate changes the biota may find it harder to adapt. The 2018-2019 summer was the second hottest recorded in Tasmania and even in the first week of March (after the start of the Austral autumn) we have seen record-breaking daily maximum temperatures. Perhaps the most worrying phenomenon, back in January, was the passage of a band of dry lightning storms that produced several hundred strikes to ground across the island without any significant rainfall. Dry lightning has been very rare in Tasmania up until now. The lightning strikes started over 50 fires, many in very remote areas. Despite efforts by the fire and national parks services to quench the fires at their start, several major blazes developed. At the time of writing (March 4th, 2019) the Tasmanian Fire Service website recorded 28 fires still burning, four of which were still at "Advice" level, i.e. still uncontrolled and with the potential to spread and threaten property.

Three of the major fires burned in the

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President's Corner

Tadashi Kawai, Ph.D.
IAA President *(Japan)*

Dear IAA members

I would like to wish you all a belated Happy New Year! 2019 is a gap year between the important events IAA22 in Pittsburgh (USA) in 2018 and IAA23 in Vodňany (Czech Republic) in 2020. Therefore, I was a bit concerned about the renewal of IAA memberships in 2019 at first. However, it seems there is no reason to worry. Immediate past president Lennart Edsman organizes a European regional IAA meeting this year, which will be a major opportunity to renew IAA memberships among European members. Also, Czech IAA members Dr. Antonín Kouba and Dr. Jiri Patoka, and Oceanian member Dr. Jason Coughran will attend the international meeting of The Crustacean Society in Hong Kong in May as invited speakers. This is a good chance to recruit new members for IAA. In particular, Antonín will promote the IAA23 symposium during the crayfish session of the meeting. For those of you who did not renew their memberships yet, I encourage you to renew your IAA membership today!

Managing editor of our journal *Freshwater Crayfish* Dr. Jim Fetzner Jr., brought some important news for the IAA. On March 29th he sent us an update on the status of *Freshwater Crayfish,* related to the inclusion in the Web of Science and obtaining an impact factor for our publication. In summary, this is the current state of affairs: For the last 4 years Jim has been submitting volumes of *Freshwater Crayfish* to Clarivate Analytics for them to review for possible inclusion in their various online products and to obtain an impact factor. He was informed that the Editorial Team would schedule an evaluation of *Freshwater Crayfish* for inclusion in the "Web of Science (WoS) Core Collection" sometime in the next few months. In order for a journal to receive an impact factor, it has to be included in this WoS Core Collection. On January 9th of this year Jim received a message, stating that *Freshwater Crayfish* was under consideration for WoS coverage.

While we appear to have crossed the first big hurdle on our way to an impact factor for *Freshwater Crayfish*, it looks like we will have another 2-year wait until we can be evaluated for inclusion in the broader Clarivate products and potentially receive an actual impact factor. They will be watching the journal closely during that timeframe to see if we can increase the number of papers published each year, as well as the citation rate of the papers. So, these next two years will be very important. We need to get the number of new submissions up drastically over this timeframe, hopefully above their 20 paper per year level. We need quality papers that will help with our citation impact. Over the long-term everyone will benefit if we ultimately end up with the impact factor we have been seeking for so long.

During the next two years IAA has to put emphasis on the further development of our journal *Freshwater Crayfish,* so that it may eventually get an impact factor. This would encourage the submission of high quality papers and strengthen the IAA as an academic society. This is the time to submit your papers to *Freshwater Crayfish*!

In order to achieve our goal, i.e. our journal to get an impact factor, I would also like to encourage the recruitment of new

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

Secretariat:

The International Association of Astacology has a permanent secretariat managed by **James Stoeckel**. Address: IAA Secretariat, Room 203, Swingle Hall, Department of Fisheries and Allied Aquacultures, Auburn University, AL 36849-5419, USA.

Tel: +1(334) 844-9249 / Fax: +1(334) 844-9208
E-mail: jimstoeckel@auburn.edu

Web page: www.astacology.org
Webmaster: **James W. Fetzner Jr.**
E-mail: FetznerJ@CarnegieMNH.org

Officers:

Tadashi Kawai, President - Fisheries Research Department, Wakkanai Fisheries Research Institute, Wakkanai, Hokkaido, Japan.
E-mail: kawai-tadashi@hro.or.jp

Javier Diéguez-Uribeondo, President-Elect - Real Jardín Botánico, CSIC, Plaza de Murillo 2, 28104 Madrid, Spain.
E-mail: dieguez@rjb.csic.es

Christopher A. Taylor, Secretary - Prairie Research Institute, Illinois Natural History Survey, 1816 South Oak, Champaign, IL, USA.
E-mail: cataylor@illinois.edu

Lennart Edsman, Immediate Past President - Swedish University of Agricultural Sciences, SLU Aqua, Institute of Freshwater Research, Stangholmsvagen 2, Drottningholm, Sweden, SE-178 93.
E-mail: lennart.edsman@slu.se

Header photograph: Noble crayfish (*Astacus astacus)* © 2018 Karolina Śliwińska

This issue edited by **Thomas Abeel**, Managing Editor
E-mail: CrayfishNews@astacology.org

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IAA members from Latin America and Africa. The European, North American and Oceanian region have a great tradition of astacology and have high numbers of IAA members. Also Asian memberships have increased during the last decade. Freshwater crayfish are distributed also in the African and Latin American region. I see that many potential IAA members have worked in both of these regions. In order to receive the impact factor for *Freshwater Crayfish*, we should encourage scientists in these two regions to submit quality papers. In this issue of *Crayfish News*, newly joined member from South America Dr. Felipe Ribeiro contributed an article on members of the Parastacidae family in Brazil. He has plans to organize a scientific symposium on crayfish in Brazil in 2020. Also, African members will submit news from Madagascar. With the addition of Latin American and African members, the IAA memberships cover the worldwide native distribution ranges of freshwater crayfish.

Tadashi Kawai
Hokkaido, Japan

Meeting Announcements

Crayfish Meeting Gotland 2019

A regional European IAA meeting will take place, August 27-30 2019, within the walls of medieval town Visby on Gotland, the largest island in the Baltic Sea. Apart from usual crayfish topics like crayfish plague, conservation, genetics, physiology, management and invasives, there will be a special theme with aquaculture in general and crayfish culture in particular. Subjects like epigenetics and risk analyses will most likely also be touched upon.

The meeting will start on August 27 with a day dealing with local and regional crayfish and aquaculture questions (in Swedish). In the evening there is a welcome reception for everyone, local regional and international alike. Then follow two days of plenary talks, contributed talks, posters and workshops. The last day, August 30, will be devoted to an excursion on Gotland visiting sites for noble crayfish farming, for extermination of the invasive signal crayfish and for restoration of noble crayfish populations. The day will end with a tour of the research station Ar on the northern part of Gotland where we will also have the conference banquet in the form of a traditional Swedish crayfish party. The meeting is organised by Swedish University of Agricultural Sciences, Blue Centre Gotland, Eastern Finland University, and Gotland County Administrative Board. Every crayscientist, crayexpert, crayenthusiast or any other type of a crayperson - meaning, farmer, manager, scientist or interested - is warmly invited to take part.

Registration and information on abstract submission and accommodation will soon be available on the webpage below:

www.campusgotland.uu.se/samverkan/bcg/kraftkonferens

Lennart Edsman
Sweden

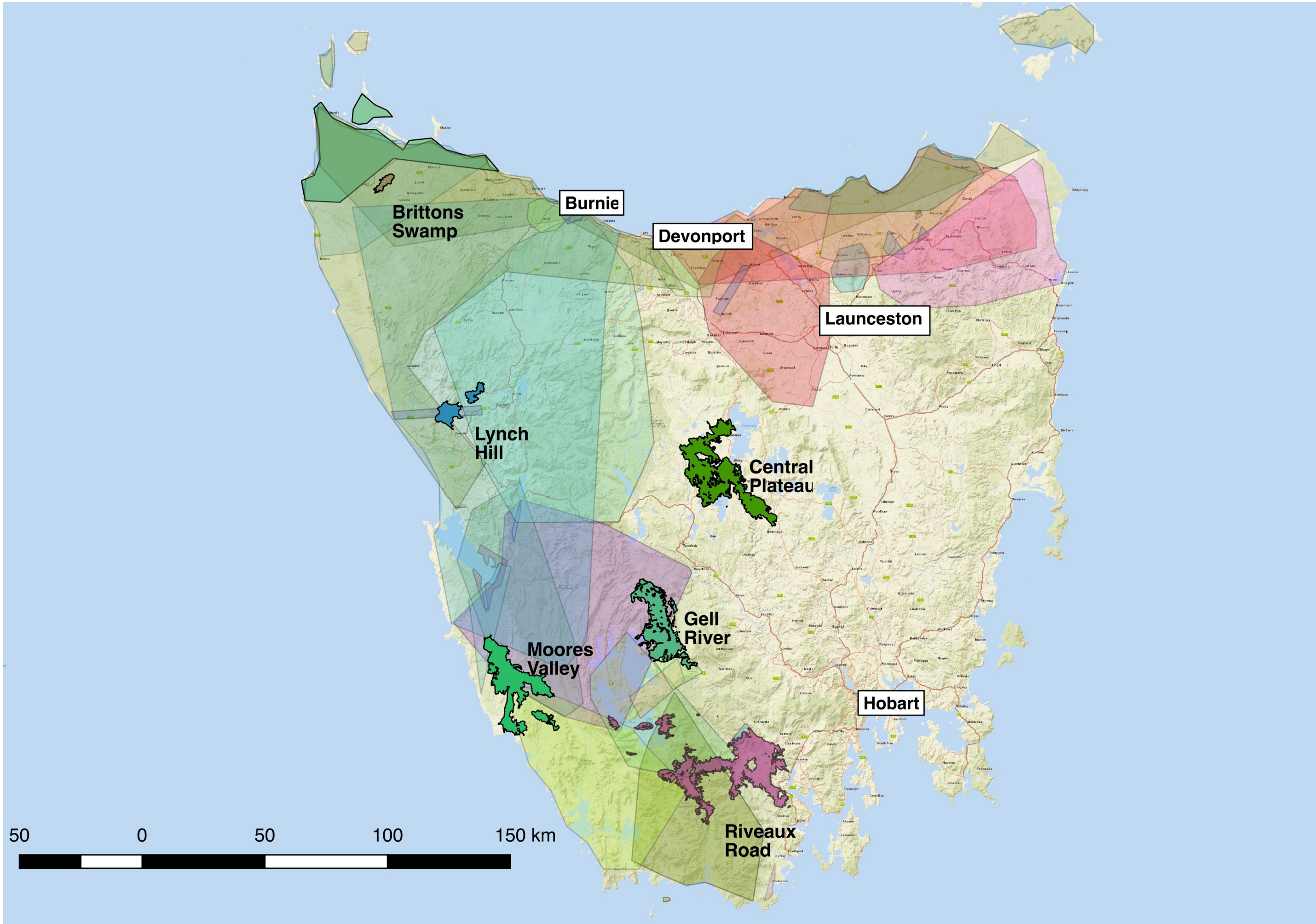

Figure 2. Tasmania, showing the major fires of the 2018-9 summer and polygons representing the distributions of burrowing crayfish.

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southwestern part of the island, while the fourth was in the southern part of the Central Plateau at altitudes between 700 and 1000 m above sea level and outside the range of burrowing crayfish. At the time of writing they had altogether burned over 1860 km^2, almost 3% of Tasmania's land area. The southwest fires were all in the range and habitat of a number of burrowing crayfish. Two other smaller fires (Lynch Hill: 91 km^2; Brittons Swamp: 24 km^2) occurred within the ranges of other burrowing crayfish in the west and northwest. I thought it might be interesting to record which crayfish species are likely to have been within the burned areas and consider the impact on their populations.

The Tasmanian Fire Service constantly monitors and maps the fire boundaries, so I overlaid them on distributional data for the crayfish, sourced from the Tasmanian Natural Values Atlas, plus some more recent records of my own. I used the fire boundaries polygons to clip minimum convex polygons drawn around the point data for each species. I modified the minimum convex polygons in some cases where the absence of crayfish was almost certain, e.g. beyond coastlines, or above certain altitudes, based on field observations. I omitted crayfish confined to Type 1 burrows (i.e. in permanent surface water, Horwitz & Richardson 1986), on the grounds that the fire would have had minimal direct impact on them. In practice these were the three *Astacopsis* species.

Table 1 lists the crayfish species found within the fire boundaries, the percentage of their range affected by the fires, and the burrow types they inhabit. Most of the 13 species found in the fire areas were from the genera *Ombrastacoides* (5) and *Engaeus* (5), followed by *Spinastacoides* spp. (3). The affected areas of the *Engaeus* species were all under 10% of their total range, apart perhaps from *E. disjuncticus*, but its range is disjunct and poorly known. The species with the greatest proportion of their range affected were *O. decemdentatus* (49%) and *O. denisoni* (46%); the latter is particularly significant, given its small overall range (33 km^2). *O. denisoni* is listed as Critically Endangered in the IUCN Red List and is recognized as a "priority species" in forestry planning in Tasmania.

The wet heaths and heathy sedgelands that are the typical habitats of most *Ombrastacoides* and *Spinastacoides* species are

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fire-prone and fire-adapted, with a natural fire frequency that may be as short as 20 years. Within four weeks of these fires, tussocks of button grass (*Gymnoschoenus sphaerocephalus*) were showing 3-4 cm of fresh growth beneath the burnt ends of their leaves. Similarly, the eucalyptus trees in the area regrow readily from epicormic shoots beneath the bark of their trunks, or from lignotubers below ground, within a few weeks of a moderate fire. Where the fires have been very intense and trees have been killed, regeneration starts quickly as seeds are dropped from the existing trees into the ash bed produced by the fire.

More permanent damage is done when fires spread into the alpine vegetation, as can happen when conditions have been dry before the fire. Tasmania's alpine vegetation is ancient, and not fire-adapted. Cushion plants (tight, hard aggregations of several small plants into "bolsters" that may be meters across) and native conifers such as pencil pines (*Arthrotaxis cupressoides*) are easily killed by fire and take hundreds of years to recover. The current fires spread into the alpine zone on the Central Plateau and in the Denison Range in the southwest. The latter area supports some crayfish, but none are confined to the alpine zone.

Given that fire is naturally-occurring in their habitats we would not expect these fires to have any severe effect on the burrowing crayfish. Since the peat soils in which they burrow are normally saturated with water, they have a huge thermal mass and the relatively rapid passage of a fire hardly heats the soil at all below a depth of a few centimeters (personal observation). Their food source (largely roots and the decaying leaves of the sedges) is only temporarily affected. I was able to collect *O. huonensis* from a site burned by the Riveaux Road fire about four weeks after, the burrows all had free water at the bottom and there were some signs of digging activity since the fire.

If the next fires in these areas were 20 years away there would be nothing to worry about. However, repeated fires can reduce the depth of the peat, or even start peat fires (which are difficult to extinguish) if the peat is dry before the fire. Where the peat cover is shallow on hillsides this can severely reduce, or eliminate, the crayfish, as has happened due to frequent fires lit by fishermen in past years on slopes immediately inland from the west coast.

A further threat to these crayfish is the predicted long-term increase in temperature and decrease in rainfall. We think that they can survive short periods (2-3 weeks?) without free water in their burrows by remaining inactive in the saturated atmosphere at the bottom of the burrow, but we do not know exactly how long they can survive that way. Climatic predictions for the

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Table 1. Five major fires in Tasmania in the summer of 2018-2019, and their impact on burrowing crayfish. Burrow types after Horwitz & Richardson 1986: 1a: entirely in standing water; 1b: in standing water, but with one or more entrances on land; 2: on land, extending down to the water table; 3: on land perched above the water table.

FIRE	FIRE AREA (KM^2)	SPECIES AFFECTED	TOTAL RANGE (KM^2)	IMPACTED RANGE (KM^2)	% RANGE IMPACTED	BURROW TYPE
RIVEAUX ROAD + SATELLITES	650+	*Ombrastacoides denisoni*	33	15	45.5	2
		Ombrastacoides huonensis	1883	198	10.5	2
		Spinastacoides inermis	2762	275	10.0	1a,1b,2
		Spinastacoides insignis	2987	44	1.5	2
		Spinastacoides catinipalmus	5490	11	0.2	1a,1b,2
GELL RIVER	363	*Ombrastacoides decemdentatus*	321	156	48.6	2
		Spinastacoides catinipalmus	5490	221	4.0	1a,1b,2
MOORES VALLEY	334	*Ombrastacoides brevirostris*	2766	216	7.8	2
		Spinastacoides insignis	2987	107	3.6	2
		Spinastacoides catinipalmus	5490	226	4.1	1a,1b,2
LYNCH HILL	91	*Engaeus disjuncticus*	245	31	12.7	2,3
		Engaeus fossor	8894	26	0.3	2
		Engaeus cisternarius	14260	93	0.7	3
		Ombrastacoides leptomerus	8023	28	0.3	1b,2
BRITTONS SWAMP	24	*Engaeus fossor*	8894	25	0.3	2
		Engaeus lengana	2797	25	0.9	1a,1b
		Engaeus cunicularius	8409	25	0.3	1b,2

Figure 3. Unburnt and burnt buttongrass heathland near Mt Anne, in the range of *Ombrastacoides huonensis* and *Spinastacoides inermis*.

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southwest of Tasmania (Grose *et al.* 2012) suggest increased summer temperatures and decreased rainfall, but some increase in winter rainfall. It remains to be seen whether the small increase in winter rainfall will compensate for increased loss in summer and autumn, but it seems likely that the ranges of species to the east will contract. *Ombrastacoides denisoni*, which has a very small range in the east, may be particularly vulnerable, and although not affected by the current fires, *O. dissitus* has the most easterly distribution of any *Ombrastacoides* species and is also restricted to quite a small range (ca. 23 km^2).

If dry lightning storms of the kind we saw in January become the new normal, increasing the frequency of fires, and if the landscape of western Tasmania becomes chronically drier, our endemic "rain crayfish" are likely to experience contraction in their ranges, particularly those species at the eastern edge of the overall range.

Alastair Richardson
University of Tasmania
alastair.richardson@utas.edu.au

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Short Articles

A Very Large Rusty Crayfish

What is the largest crayfish among a sample population that you have encountered in the field? While collecting Rusty Crayfish (*Faxonius rusticus*, Girard) as part of a recent study, I collected a Form I male measuring 57.5 mm in carapace length (CL) within a small stream (Sechler Run) near Danville, Montour County, Pennsylvania, USA. The body size of the crayfish was a notable outlier in my dataset: mean CL of Rusty Crayfish (N = 63) collected at this site was 32.2 mm (± 8.0 mm). The largest reported maximum size I can find for Rusty Crayfish is 50 mm carapace length (reviewed in Jezerinac et al. 1995), based on the literature I have on hand. Is the crayfish I found a new size record for this species? I certainly wouldn't be so bold as to say so. Considering the rather large volume of studies focused on this species, perhaps a larger size record has been documented which I have overlooked. However, this specimen still appears to be an exceptional size record for this species. The specimen was preserved along with the others collected at this site, but has since been destructively sampled as part of a separate study. In hindsight, I wish I would have kept this one!

Sean M. Hartzell
Dept. of Biological and Allied Health Sciences
Bloomsburg University of Pennsylvania
seanhartzell77@gmail.com

Reference

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Systematics and Conservation of Freshwater Crayfish in Brazil

Parastacid crayfishes are distributed along the Southern hemisphere, except in continental Africa and Antarctica. In South America, there are three genera and 19 species. The richest genus is *Parastacus* with 14 species distributed in Brazil, Uruguay, Argentina and Chile. In the Brazilian freshwaters, crayfishes occur only in the southernmost portion of the country, the states of Santa Catarina and Rio Grande do Sul. They can be found in streams, lakes, burrows, caves and swamp forests of the biomes Atlantic Forest and Pampa.

The studies on freshwater crayfish in Brazil began with Professor Ludwig Buckup from Universidade Federal do Rio Grande do Sul (UFRGS). He published a taxonomic review of the genus *Parastacus* in 1980, with the description of a new species, *Parastacus laevigatus* from the northern portion of the state of Santa Catarina. He also published several works on the biology of burrowing species of *Parastacus*, covering mainly reproductive and behavioral aspects. He gets retired in 1990, but keeps participating in numerous research and extension activities inside and outside the University for a few more years.

Figure 1. *Parastacus caeruleodactylus*

Figure 2. *Parastacus tuerkayi*

Studies on freshwater crayfish in Brazil resurrected with the initiative of Professor Dr. Paula Araujo from UFRGS developing of the project “Limnetic ecosystems and conservation of the freshwater crayfish of the genus *Parastacus* (Crustacea, Decapoda, Parastacidae) in southern Brazil”. She gave the opportunity for PhD students to develop research on systematics and conservation of the Brazilian crayfish. As my supervisor, Professor Paula Araujo encouraged and supported me to enter inside the world of crustacean taxonomy. Other research lines coordinated by Professor Paula Araujo were the distribution modeling of South American crayfish, developed by Dr. Kelly M. Gomes in her phd thesis, and biology, genetics and management of invasion of the red swamp crayfish *Procambarus clarkii* in Brazil, developed by Dr. Tainã Loureiro in her phd thesis.

The goals of my thesis were to review the taxonomy of *Parastacus* and to investigate the monophyly and phylogenetic relationships within South American crayfish genera. For this purpose, I visited several collections and museums around the world (Brazil, Argentina, Uruguay, Chile, United States of America, Germany, Netherlands, England, and France). This taxonomic review included about 360 lots and almost 900 specimens of crayfishes. The

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conduction of this work provided the discovery of more than 30 new species of *Parastacus* after a gap of more than 35 years since the description of *P. laevigaus* Buckup & Rossi, 1980. Five new species were already described and published: *P. fluviatilis* Ribeiro & Buckup in Ribeiro *et al*. (2016), *P. caeruleodactylus* Ribeiro & Araujo in Ribeiro *et al*. (2016), *P. tuerkayi* Ribeiro, Huber & Araujo in Ribeiro *et al*. (2017), *P. buckupi* Huber, Ribeiro & Araujo, 2018 and *P. pilicarpus* Huber, Ribeiro & Araujo, 2018. The remaining new species are being described now during my post doctorate using integrative taxonomy throughout morphological, molecular and ecological tools besides the analysis of the conservation status.

Genetic analyses are very important in the recognizing of cryptic species. Phylogenetic reconstructions based on mitochondrial and nuclear markers indicated the existence of multiple lineages in *P. brasiliensis*, of which only one can be considered as *P. brasiliensis sensu stricto*. In addition, seven other lineages were identified, one of which was the subspecies *Parastacus brasiliensis promatensis* Fontoura & Conter, 2008, which was elevated to species level. Our findings lead us to encourage the establishment of preservation areas for isolated populations, preserving the newly recognized distinct gene pools in order to maintain overall genetic diversity.

Evidently, our research gets improved

Figure 3. Huge chimney of *Parastacus sp*.

with good partnerships. In this way, we established partnerships with Dr. Christoph Schubart from Universität Regensburg (Regensburg, Germany), Dr. Catherine Souty-Grosset from Université de Poitiers (Poitiers, France), Dr. Augusto Ferrari from Universidade Federal de Rio Grande (FURG) (Rio Grande, Brazil), Dr. Ana Verdi from Universidad de la Republica (Montevideu, Uruguay) and Dr. Keith Crandall from George Washington University (Washington D.C., U.S.A.).

Future directions of the astacological research in Brazil includes a biogeographic analysis of the genus *Parastacus* based on a new phylogenetic proposal, a comparative analysis of the morphology of the gastric mill ossicles of *Parastacus*, and the identification of

Figure 4. In the field

other cryptic species through integrative taxonomy, besides the description of several new species that are being found almost every fieldwork.

Felipe B. Ribeiro
Post doctorate researcher
Universidade Federal do Rio Grande do Sul
Zoology Department
Brazil
fbribeiro.bio@gmail.com

Reference

N. F. FONTOURA & M.-R. CONTER. 2008. Description of a new subspecies of the crayfish *Parastacus brasiliensis* (Von Martens, 1869) from São Francisco de Paula, RS, Brazil (Decapoda, Parastacidae). Zootaxa 1849: 28–34.

Where do Branchiobdellidans (Crayfish Worms) go in the Winter?

This is a simple, but vital question in understanding how branchiobdellidan populations survive from year to year in northern areas with periods of subzero temperatures in winter. The present study is part of a broader, ongoing investigation by Tadashi Kawai into the population ecology of the endangered, endemic Japanese crayfish, *Cambaroides japonicus* (De Haan, 1841).

Branchiobdellidans, or crayfish worms, are ectosymbionts that live primarily on freshwater crayfish in three separate regions within the Holarctic realm: East Asia, Euro-Mediterranean and North America (Gelder, 1996; Gelder and Williams, 2015). In each region they enjoy mild or warm, ice-free winters in the south (South China, Mediterranean and Central America) to winters with frozen water bodies lasting months in the north (Southeastern Russia, Scandinavia and Prairie Provinces of Canada). Efforts to determine how and where branchiobdellidans spend and survive the winter in these northern areas have been largely unsuccessful. The primary reason being, that known branchiobdellidan sites usually become inaccessible for collecting crayfish during these frigid periods (Ohtaka and Gelder, 2015: 70). Crayfish, and presumably their ectosymbionts spend

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Figure 1. Shihoro, Tokachi Region. Natural habitat of the endangered, endemic Japanese freshwater crayfish *Cambaroides japonicus* in late winter (Photo by M. Yamada, taken on March 15th, 2017).

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the winter in one of two habitats, either in water or in burrows. While burrows offer protection, they need to extend below the frost line which is regularly 1 to 2 m deep, or have part of the burrow connected to underground water system, otherwise it can be safely assumed the branchiobdellidans would freeze and die. Kolesnikova (2008) collected *Astacus leptodactylus* Escholtz, 1823, carrying *Branchiobdella kozarovi* Subchev, 1978 from an ice-covered lake in the Ukraine, while Dr. Bronwyn W. Williams (pers. comm.) has obtained branchiobdellidans on crayfish from flowing streams in the USA where the water temperatures neared 0 °C. In contrast, DeWitt et al. (2012) reported that *A. leptodactylus* collected from the Aras Reservoir in Iran did not carry their usual *B. kozarovi* during the winter when the water temperature fell below 5 °C. The latter appears to be the usual situation during winter. It is believed Japanese crayfish hide in burrows or under large boulders over the winter where the water does not freeze (Kawai, unpublished observation).

A total of 11 species of *Cirrodrilus* have been collected from *C. japonicus,* according to Ohtaka and Gelder (2000). The host's range is restricted to northern Honshu and Hokkaido Islands in Japan. As all of these species, crayfish and branchiobdellidans, have been designated as endangered by the Environmental Agency of the Government of Japan (www.env.go.jp/press/files/jp/20556.pdf), it is vital to know all aspects of their life cycle and interactions so that the most efficient conservation programs can be developed and managed. When endangered *C. japonicus* are collected, as much information as possible is recorded in addition to that of the current project so as to maximize the knowledge obtained from these threatened populations. Although this project focused on branchiobdellidan survival during the winter, information on the hosts was recorded, the use of radio telemetry tracking was refined, and body tissues were preserved for ongoing population genetic studies (see end note).

Specimens of *C. japonicus* carrying branchiobdellidans *Cirrodrilus* sp. were collected from streams around Shihoro, Tokachi Region

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and the western foot of Mount Oribeyama, Hokkaido, Japan, on 10th August 2016, by Tadashi Kawai. Selected crayfish at all three locations were fitted with a radio telemetry tracking system in preparation for winter collections. A pre-winter sampling of *C. japonicus* on 17th December 2016 at all three sites confirmed the telemetry system could locate the crayfish in their stream habitat where the water temperature was 5.4 °C. None were found in burrows.

The sites around Shihoro, were visited twice in the winter and a total of six *C. japonicus* were collected. In February the streams had a 20 cm thick covering of ice which was broken using a hammer and the ice fragments removed for access to the water, but by March, a little open water had appeared (Figure 1). Using the telemetry trackers, crayfish were found under a large boulder (0.5 m wide) where they had been found during the preliminary survey. After capture, crayfish were transported alive to the laboratory where a standard protocol was followed: their sex and size (post-orbital carapace length) were recorded, then they were submerged separately into 70% ethanol solution in a screw-top container and gently shaken. Detached worms and any remaining on the exposed surface were removed, placed into specimen tubes with 70% ethanol for either subsequent molecular analyses or morphological observations. The examination was completed by exposing the branchial chambers and any branchiobdellidans found there were transferred to separate specimen tubes.

On 17th February 2017, the water temperature was 0.4 °C and three crayfish were captured: a male (POCL 26.4 mm) and two same-sized females (POCL 24.1 mm), while on the 15th March 2017 (Figure 1), with a water temperature of 2.2 °C, another three were collected: a male (POCL 19.6 mm) and two females (POCL 17.7 mm and 20.0 mm) - the latter being ovigerous. Unfortunately none of the crayfish were carrying worms or cocoons. The question for astacologists and branchiobdellidanologists alike remains, where do the crayfish worms go in the winter?

The authors sincerely thank Mr. Masayoshi Yamada of Zukosha Co. Ltd. who kindly provided the crayfish for the present study, and Professor Akifumi Ohtaka of Hirosaki University for suggestions on how best to search for branchiobdellidans in the winter.

Note:

In previous capture and release field studies of endangered Japanese crayfish populations (Tadashi Kawai), specimens were sexed and morphometric details recorded, and then branchiobdellidans were removed before returning the host to the water. Detachment of branchiobdellidans from the crayfish's exposed surface was achieved by placing the host briefly in a formalin solution. The strong body movements reacting to the formalin solution rapidly freed most worms from the exoskeleton. Although the formalin solution was very dilute, a small amount was introduced into the stream on releasing the live crayfish - this is now environmentally unacceptable. The formalin solution has now been replaced with a 25% ethanol solution. This is just as effective in detaching branchiobdellidans, but has less detrimental effect on the crayfish and none on the water quality when the crayfish are released. The detached worms are now quickly transferred into specimen tubes containing 70% ethanol for storage and transportation. There are two additional advantages to this ethanol protocol: 1. the dehydration process for slide mounting is shorter, as specimens no longer require a long washing time to remove the formalin and the sequence starts at the 70% ethanol stage, and 2. specimens are available for gene sequencing.

Tadashi Kawai
Hokkaido, Japan
kawai-tadashi@hro.or.jp

Stuart R. Gelder
Maine, USA

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Update from the IAA Deep South

In December last year I had the pleasure of visiting New Zealand to look at a freshwater crayfish farming operation run by IAA member John Hollows. For those of you new to IAA: John Hollows farms freshwater crayfish in many hundreds of earthen ponds in production forests that are not linked to each other or waterways. The ponds rely on rainwater, springs and seeps for water and receive no feeding or aeration. While there is no reported crayfish plague in New Zealand, John's work highlighted that they have created a farming model that has little concern with disease or predator infiltration which may have implications for the long-term survival of native crayfish species in Europe.

II examined hundreds of specimens and found that crayfish health was excellent without even appendage damage, which is the first sign of aggression at high density. These animals were clearly at high density and yet they had enough refuges, plus good water quality and so the high populations were not causing issues. The pond design ensures that refuges are created within the pond infrastructure. By giving the ponds enough time to establish, they are already a fully functioning biotope, with a natural filtration system in place, before the crayfish are added. We have adopted a stocking strategy to ensure that the females and youngsters have enough room to grow and rear their young without larger males dominating them and supressing their growth. These are similar findings to those I have found through my ex-situ research studies in the UK, working with native white-clawed crayfish *Austropotamobius pallipes*. It is encouraging and reassuring to find that, even in different freshwater crayfish species, the basic characteristics and behaviour patterns can be similar. It was fantastic to see how a commercial forestry company can work in synergy with a conservation programme and see how mutually beneficial the two things can be. These ponds are not only a fantastic sustainable source of crayfish but also provide a very vital service to protect against forest fires and produce an income by harvesting the crayfish for the food market. We probably would never harvest our UK native crayfish species for the food market, but we could hopefully adopt the same approach and create similar ponds throughout our woodlands. We have an ark-site programme for crayfish in the UK, where we move threatened wild crayfish populations to safe sites and produce captive-bred animals for arks. However, we normally select suitable river catchments or larger still-water sites to utilise. If a pond on this NZ scale could also work in the UK, it could provide many more opportunities for ark-site creation on our island!

It was great to see that there was also a strong communication/ outreach element to John's programme and how successful his

Figure 1. Jen Nightingale and John Hollows sampling crayfish in a New Zealand forest

Figure 2. Aisling and John collecting samples for genetic analysis.

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Figure 3. John Hollows in his natural habitat!

Figure 5. Picture of Holly in a test pond to see if the New Zealand model could work for conservation in Britain.

Figure 4. Students from Bluff School (mainland New Zealand's most Southern school) during a freshwater crayfish conservation/education day run by John.

(Continued from page 11)

company has been in raising the profile of crayfish and their work in New Zealand. John has publicised his aquaculture methods throughout New Zealand and has an active programme teaching New Zealanders about crayfish conservation. In the UK, an important part of our crayfish conservation programme is education and it is very encouraging to see how much importance is also put on this element in New Zealand.

I was so motivated by my visit that, within a month of returning home, we have dug a pond replicating the 'Hollows method', within a woodland area of our zoo. We will watch and monitor it closely for the next 20 months, with a view to stocking it with crayfish in late 2020. It was an absolute privilege to see John's work, assist him with an exciting genetic study looking at the consequences of 'genetic rescue' translocations that aim to increase genetic diversity in small, inbred founder populations (led by PhD candidate Aisling Rayne from the University of Canterbury). This data will inform guidelines around how freshwater crayfish are farmed to enhance resilience and commercial productivity in our aquaculture ponds. Aisling's research has further conservation and recreational harvest implications for declining New Zealand freshwater crayfish (*Paranephrops zealandicus* and *P. planifrons*) populations which may also benefit from genetic rescue.

I was very encouraged by what I saw working so well and have brought home with me a new energy and determination to adopt part of the Hollows methodology to roll out in the UK.

Jen Nightingale

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To view abstracts, etc., click on a reference to be taken to the journal website (some references may not contain links).

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