Sven Gehrmann

General Freshwater-Crustacean Practice

Fresh- & Brackish-Water Crayfish, Shrimps, Prawns, Crabs, Hermits & Horseshoe Crabs

PROLOGUE

The first crayfish species I kept in a cold-water aquarium was the crayfish ***Orconectes limosus***, introduced from North America. At that time, in the mid-1980s, this species was, as a precaution, hardly mentioned at all in aquarium literature. The only reference I found was in Hans Frey's work "Aquarienpraxis kurzgefasst". There was a short section on the care of this North American crayfish, consisting of maybe 5-6 sentences and a black and white line drawing. At that time, nothing was published about crayfish pestilence and the problems associated with it, purely as a precaution. Tropical crayfish were rarely sold in the aquarium trade at that time, and then it was mostly the **Red Swamp Crayfish *Procambarus clarkii***, whose breeding was celebrated as a sensation in the aquarium magazines of the time! During the rest of my school years

from 1985 to 1988, I was a member of a biology club that not only had many a water fight in the school's climate chamber during breaks, but also always acquired various interesting animals. During this time I procured crayfish from the edible crayfish trade for the first time, and managed to find **Swamp** and **Signal Crayfish**. During this time I also had my first experience with the crayfish pestilence, which killed all **Swamp Crayfish**. I had bought from "Nordsee" one by one. At about the same time I was looking for crayfish in a nearby gravel pond and found them rather by chance. Apart from the crayfish, I also caught the **Freshwater Shrimp *Atyaephyra desmarestii*** as a by-catch, which I could only identify with the help of the GDR reference book by Stresemann. A remarkable achievement, considering that at that time there was neither popular scientific literature on these animals nor the aid of the internet. This book thus contains my lifeblood, which has flowed over many years for these animals. You may forgive me for my strong language when I recommend cooking them in the chapter about the **North American Crayfish**, but this species is the first one I caught and kept in the aquarium myself. Since I sometimes also preserve animals and have occasionally dealt with their interior, please forgive me that I do not consider crayfish to be cuddly animals, nor do I intend to trivialise or humanise them. Rather, my intention with this work is to introduce the crustaceans of freshwater. I also want to contribute to creating a new awareness for the conservation of endemic species and their habitats. And finally, I would like to challenge the many aquarium enthusiasts in particular to deal responsibly with these versatile and interesting animals. If I were to advocate for anything, it would always be uncompromisingly for the cause of crustaceans and the conservation of their habitats. Unfortunately, it is a sad fact, that every day about 250 species disappear irretrievably from our planet due to anthropogenic influences. Also, many

researchers and climate experts now assume that climate change will mean certain extinction for about 30-40% of the animal and plant species known today. What never ceases to amaze me is the indifference and ignorance of most people towards these well-known hypotheses and facts. But what can we do ourselves to slow down the decline at least a little and to preserve the (still) existing biological diversity for our children? Well, this path may seem uncomfortable, but it starts with each and every one of us. In principle, it means renunciation. Renunciation of unnecessary consumption as well as renunciation of unnecessary luxury and unnecessary transport. Let me give you an example: The overproduction of meat in Germany has become increasingly grotesque in recent decades. In the meantime, grain has to be imported from countries such as Paraguay so that we can feed our own cattle, because in Germany it is no longer possible to produce such quantities of grain... This has dramatic consequences for the poor small farmers in Paraguay, who are simply driven off their fields to increase soy production and are also poisoned with pesticides. But the consequences of this madness are also becoming visible in Germany, because where fattening farms dispose of their manure, the nitrate levels in the drinking water are rising alarmingly, in some places to 100 milligrams of nitrate and more! Although I am not a pure vegetarian either, I am of the opinion that one can reduce one's meat consumption in order to counteract such circumstances. Even refraining from consuming pork can make a big difference, as the pig industry is unfortunately one of the most destructive forms of our agricultural economy. Did you know, for example, that about one third of the pigs produced do not even reach the market, but are "disposed of" in a completely senseless way? Another example of the most serious environmental destruction is the automobile. The production of just one car consumes up to 400,000(!) litres of drinking water, not to mention the electrical energy. And this is produced with

harmful brown coal... Is there anything surprising about that? If we all don't learn to do without in the foreseeable future, we will soon feel the consequences of our unholy actions. For example, in the heatwave summer of 2018, river levels dropped dramatically, making even large bodies of water like the Main and Elbe partially unnavigable. From the North Sea coast to Saxony, the inland dried up... Therefore, it is a heartfelt request to my readers to seriously think about how to find good solutions on a small scale. I am convinced that not only the crustaceans of our inland waters will thank us for this. But also our children's generation. So, let's just be the miracle ourselves! Let's give up cheap flights, unnecessary car journeys, cheap rotten meat and disposable plastic products.

Sven Gehrmann, spring 2021.

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Crayfish from Australia

Crayfish from Europe

Sex differentiation in European Crayfish

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Long Clawed Crayfish, *Astacus leptodactylus*

Signal Crayfish, *Pacifastacus leniusculus*

Crayfish pestilence - chronology of an epidemic

Crayfish from America

Family *Cambaridae* - Crayfish from North and Central America

Red Swamp Crayfish, *Procambarus clarkii*

North American Crayfish, *Orconectes limosus*

Blue Florida Crayfish, *Procambarus alleni*

Marbled or Self-Cloning Crayfish, *Procambarus cf. fallax*

Cuban Crayfish, *Procambarus cubensis*

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Infraorder *Caridea* – True Shrimps

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Amano Shrimp, *Caridina multidentata*

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Crystal Red Shrimp, *Caridina cf. cantonensis*

Bamboo Shrimp, *Atyopsis moluccensis*

Superfamily *Palaemonoidea* – Glass-Prawns

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Red Claw Shrimp, *Macrobrachium dayanum*

Indopacific Glass Prawn, *Macrobrachium idea*

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Infraorder Brachyura – True Crabs

Infraorder *Brachyura* – True Crabs
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Mouthless Land Crab, *Cardisoma crassum*
Family *Grapsidae* – Talon, Shore or Marsh Crabs
Mitten Crab, *Eriocheir sinensis*
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Siam Crab, *Thaipotamon siamense*
Family *Sesarmidae* - Mangrove Crabs
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Tree Climbing Crab, *Episesarma mederi*
Family *Portunidae* - Swimming Crabs
Pelagic or Blue Swimming Crab, *Portunus pelagicus*
Green Shore Crab, *Carcinus maenas*
Mediterranean Green Crab, *Carcinus aestuarii*

Infraorder Anomura – Squat Lobsters, Porcelain Crabs & Hermit Crabs

Infraorder *Anomura* – Hermits & other
Family *Aeglidae* – Freshwater Squat Lobsters
De La Plata Squat Lobster, *Aegla platensis*
Family *Coenobitidae* - Land Hermit Crabs
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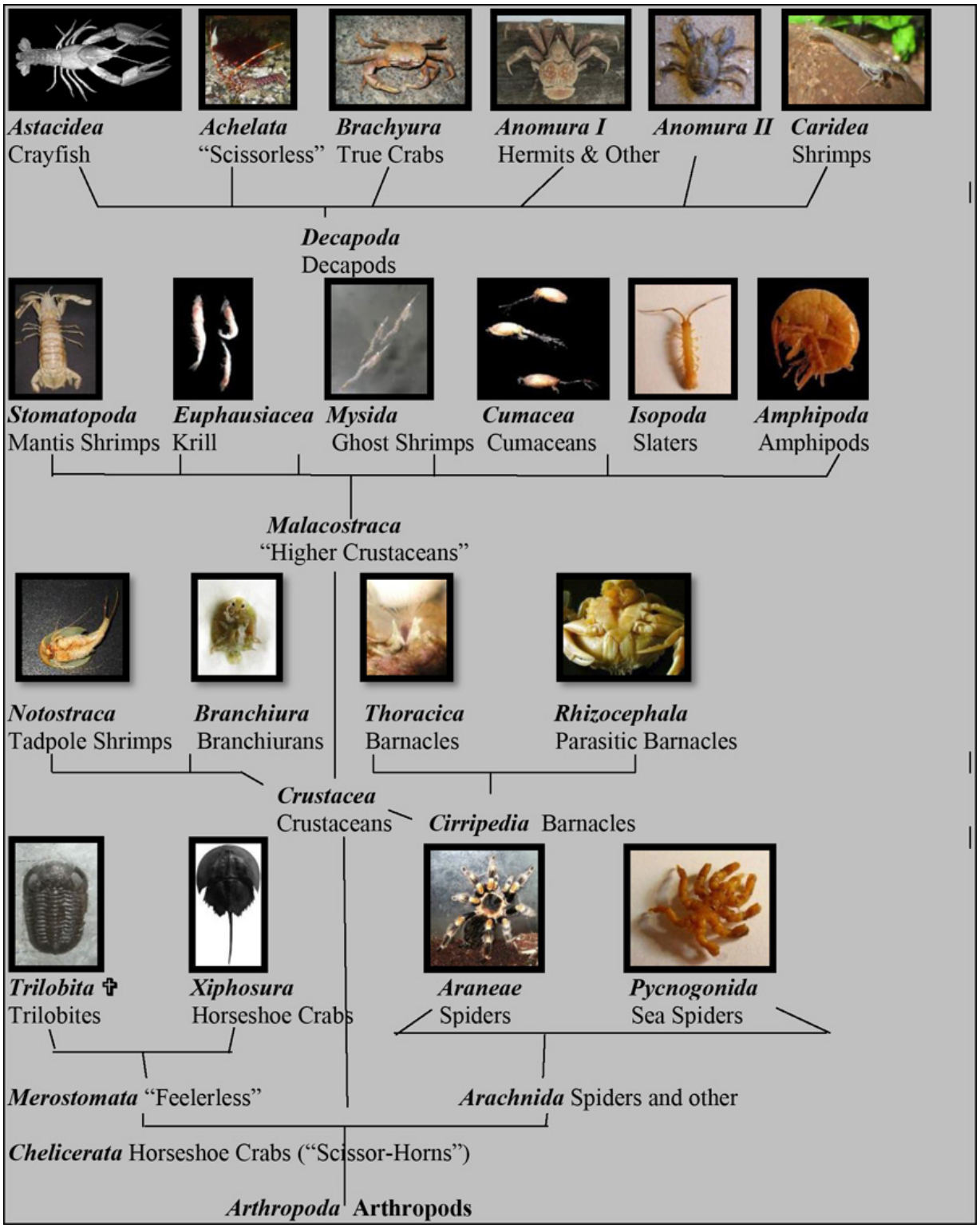
Class Merostomata – Horseshoe Crabs (“Feeler-Less”)

GENERAL SECTION

A nerite rides around on this male Australian Red Claw....

Excerpt from the systematics of the *Arthropoda*


Astacidea Crayfish
Achelata "Scissorless"
Brachyura True Crabs
Anomura I Hermits & Other
Anomura II
Caridea Shrimps
Decapoda Decapods
Stomatopoda Mantis Shrimps
Euphausiacea Krill
Mysida Ghost Shrimps
Cumacea Cumaceans
Isopoda Slaters
Amphipoda Amphipods
Malacostraca "Higher Crustaceans"
Notostraca Tadpole Shrimps
Branchiura Branchiurans
Thoracica Barnacles
Rhizocephala Parasitic Barnacles
Crustacea Crustaceans
Cirripedia Barnacles
Trilobita ✞ Trilobites
Xiphosura Horseshoe Crabs
Araneae Spiders
Pycnogonida Sea Spiders
Merostomata "Feelerless"
Arachnida Spiders and other
Chelicerata Horseshoe Crabs ("Scissor-Horns")
Arthropoda **Arthropods**

Some remarks on the meaning and use of systematics

When the ***Systema naturae*** of the Swedish scientist Carl Linne`(Latinised = "LINNAEUS") was introduced in 1758, a kind of "gold rush" will have broken out among scholars at that time. With the help of Carl Linne's guidelines on the system and determination of species, everyone wanted to make a name for themselves as quickly as possible by describing as many different species as possible. The scientists of the time were also vain fellows or were under pressure to obtain research funds from princes and kings, so they naturally wanted to show achievements. In addition, communication routes were long and international exchange was difficult in a Europe that consisted of many small states and principalities with many customs, borders and the like. Due to these circumstances, many animals were described twice and three times; some, such as the actinia of the genus ***Urticina***, were even described 42 times as a different species due to the colour variability of the species, although they were only 3 or 4 different species. I too have misidentified quite a few animals over the years, especially in the time when there was no internet and some genus and species revisions were being carried out. But how was the Carl Linne` system actually meant? Let us take a look at how a taxonomist would classify a **European Noble Crayfish**:

Domain: ***Eukaryota*** (Living being with cell nucleus and cell membrane) Whittaker & Margulis, 1978 – eukaryotes.

Kingdom: ***Animalia*** (Animals) Linnaeus, 1758 - Linnaeus, 1758 – animals.

Subkingdom: ***Bilateria*** (Bilateral animals) (Hatschek, 1888) Cavalier-Smith, 1983 - (Hatschek, 1888) Cavalier-Smith, 1983 – two sided animals.

Branch: ***Protostomia*** (protostomes) Grobben, 1908 - Grobben, 1908 – protostomes.

Infrakingdom: ***Ecdysozoa*** (ecdysozoans) Aguinaldo et al., 1997 ex Cavalier-Smith, 1998 - Aguinaldo et al., 1997 ex Cavalier-Smith, 1998 – animals, which must slough.

Phylum(Tribe): ***Arthropoda*** (Arthropods) Latreille, 1829 - Latreille, 1829 – arthropods.

Subphylum(Subtribe): ***Crustacea*** (Krebstiere) Brünnich, 1772 – Crustaceans.

Class: ***Malacostraca*** (Higher Crustaceans) Latreille, 1802.

Superorder: ***Eucarida*** (Long tailed Crayfish) Calman, 1904.

Order: ***Decapoda*** (Decapods) Latreille, 1802 – Decapods.

Infraorder: ***Astacidea*** (Crayfish and Chelate Lobsters) Latreille, 1802 - Crayfish and Chelate Lobsters.

Family: ***Astacidae*** (True Crayfish).

Genus: ***Astacus*** (Crayfish) (Linnaeus, 1758).

Specific name: ***astacus*** (Noble Crayfish) Linnaeus, 1758.

Very many scientists were involved in creating this taxon-tree over many ages…

Scientific name (Genus and species): *Astacus astacus,* Linnaeus, 1758.

Due to international rules, the systematics of animals is mostly presented in English and Latin or Greece. Every living being on our planet can be assigned its place in this system. The best way to imagine this system is as a large shelf with many niches that have certain designations and in which the corresponding creatures can be sorted. However, Carl Linne's original system has been expanded and improved many times in the meantime, as more and more animals and plants have been discovered, that cannot be classified into simple categories, as they often move systematically between different gradations or represent transitional forms. In the example above, the scientist and year to which each stage is to be assigned was indicated behind it. This shows that the taxonomy of living organisms can still change and expand; therefore, this system must not be understood as a rigid static structure. Rather, the

structure grows with the state of research, and it is conceivable that the example shown above will need twice as much space in a hundred years' time, viewed from top to bottom, because even more fine gradations have been added. I consider it particularly important to indicate the name of the first describer of a species and the corresponding date of the description after the Latin double name, because one can only assume a secure species if one has found these dates. Unfortunately, some species and/or genera are checked and revised again and again, so that one can never assume that the result of a determination will last forever. Therefore, if you want to maintain a professional collection, you should always check the topicality of the nomenclature at intervals of a few years with the help of up-to-date internet sites. For this purpose I particularly recommend the use of ZIPCODEZOO.COM. If possible, one should prefer official sites of the respective universities and always take into account that even the experts unfortunately do not agree on some things so quickly and in some cases even publish different data. In my excerpt from the Systematics of Arthropods, I myself have divided the **Anomura** into **Anomura I** and **Anomura II**, because I think it is likely, that a revision will still be made in this area. This is because Hermit Crabs on the one hand and porcelain and King Crabs on the other show very considerable morphological variations, so that one has to wonder here whether the classification of these animals in the same order is correct. It is my hope that molecular genetics will provide new results on this in the near future. And that taxonomists do not invent more taxa that complicate the systematics even more... Finally, it should be noted that the concept of species in biology is unfortunately not clearly defined at present. Molecular geneticists are arguing with morphologists and others; the outcome is uncertain. Is there any objective truth here at all? Probably everything is in flux at the moment! Only one thing is

certain: it is not as simple as we were taught in school thirty years ago. We now know that species evolve from other species. And that in some cases even apparently different species can interbreed and produce fertile offspring. Until recently, this was considered an important criterion for species delimitation. It is possible that the importance of molecular genetic analyses is simply overestimated or even misinterpreted at the moment. Therefore, not everything that comes from this branch of research should immediately be considered objective and true. After all, the scientists of this faction could ultimately be just as addicted to profiling as their colleagues were in Carl Linnes` days. And unfortunately, it is also a deplorable shortcoming, that research work nowadays tends to be project- and goal-oriented. Because research also costs money, of course, and hardly anyone can work for free or for God`s wages. As a result, today's scientific world is not opinion-neutral or independent, which is why it often adopts the premises of its clients. This then distorts the results accordingly. So one should not be too faithful to science and better not expect value-neutral objectivity. On the other hand, you can also become a researcher yourself by writing down your observations and communicating them to others. In this way, even hobby researchers can often make a valuable contribution that is above all not unobjective due to commercial requirements. (Some hobbyists have even described new species). Become an unbiased nature researcher, too!

Keeping crayfish in aquaria

Let's be realistic: we will never succeed in recreating nature's model 100 per cent in our aquaria. All we can do is to make life in the aquarium as pleasant as possible for our animals, so that they feel completely at ease and also reproduce here. In doing so, it may be, that what is not pleasing to the eye is ideal for the animals and vice versa. On the one hand, crayfish do not like sterile aquaria that always look clean and tidy, as if a cleaning fairy had been at work only yesterday, but on the other hand, the question of water quality should not be neglected. I would therefore describe optimal crayfish tanks as being characterised on the one hand by consistently good filtration and regular water changes, but on the other hand also by a wealth of structures, cover and retreat possibilities for the animals and by well-kept detritus accumulations in certain places. My crayfish aquaria are usually set up according to the same basic idea, which I would like to briefly introduce here. But let's start with the substrate: I prefer layers of fine sand, whereby the layer height of the sand can be up to 10 centimetres or more. In this concept, the substrate is also used as a filter. With a substrate placed in this way, three layers form after a short time, which are important for water purification. The uppermost layer up to a depth of about 5 centimetres can be described as an oxic layer, in which there is still a relatively high oxygen content. - This is followed by a suboxic layer, which runs from about 5 centimetres to 8 centimetres deep and already contains considerably less oxygen. Below this is an anoxic layer, in which numerous anaerobic bacteria live, which utilise the metabolic waste products of other organisms. This layer in

particular acts like a natural sewage treatment plant and breaks down nitrate. Blue-black bacterial discolouration often occurs in this layer. Especially in this lowest anaerobic zone, nitrate is split into pure nitrogen and pure oxygen by the anaerobic bacteria groups, so that an enormous nitrate decomposition takes place. Gas bubbles form in the substrate, which leave the aquarium after a while via the water surface. The older this substrate gets, the higher its biological efficiency. The main advantage over other substrate materials, such as gravel, is, that due to the fineness of the sand, it is relatively difficult for organic waste to penetrate these anoxic layers, so that no foci of putrefaction with sulphates (sulphur compounds) can form here. Another advantage of sand is, that it is a very inexpensive substrate that can be partially vacuumed out and renewed at any time. I have found commercially available bird sand, from which I rinsed out the aniseed oil before using it at home, to be a good choice. Parrot sand, on the other hand, should not be used, because it contains caustic lime, which unfortunately makes it unusable for aquarium purposes. Once you have created such a biologically functional substrate, you no longer need any elaborate filter systems, because the substrate already performs this function. Nevertheless, the strongest possible water circulation should be ensured by one or more pumps. In my crayfish tanks, the external filter of the brand "EHEIM-Liberty" has proved particularly effective, as it brings a strong, adjustable current into the water and at the same time removes considerable amounts of organic waste from the aquarium through easy-to-clean filter cartridges, so that it can be taken out of the water cycle. Another function of the sandy bottom, that should not be underestimated, is, that the crayfish can also occupy themselves sensibly here - just like in nature - by digging. I am convinced, that some animals become aggressive in the aquarium, because they do not have these opportunities to occupy themselves.

Therefore, one should tolerate the redecoration of the tanks by the crayfish within certain limits. All structures in a crayfish aquarium should be built in such a way that the crayfish cannot bring them down. If larger stones are to be used, they should be placed on polystyrene or Plexiglas sheets to prevent the bottom from cracking. This is especially true when keeping larger crayfish species, which can reach final sizes of 10 centimetres and more. I think planting is rather unsuitable for most crayfish tanks, as most crayfish regard plants as food. You can help yourself with foliage and plastic plants. Foliage is a staple food of most crayfish anyway and promotes their health, as beech foliage, for example, contains substances that act like antibiotics. And many crayfish species also like waterweed very much. These natural foods contain numerous vitamins and dietary fibres that significantly increase the vitality of the animals. Conversely, the absence of these nutrients can produce pigment deficiency and moulting problems. Therefore, you should always make every effort to provide your pets with the best possible nutrition.

Plastic plants are a real alternative for crayfish tanks with herbivorous crayfish species; you might want to attach them to the bottom of the aquarium with some silicone. By the way, silicone also hardens under water and can thus be added to the aquarium afterwards.

Artificial rock backwalls are very decorative, but must be secured with Plexiglas plates at the top, otherwise the crayfish can climb behind them. Here a tank with Apricot Crayfish *Cherax holthuisi* and Dwarf Rainbowfish *Melanotaenia praecox*.

This aquarium was stocked with Dwarf Rainbowfish and Apricot Crayfish. *Cryptocoryne wendtii* proved to be a grateful and durable plant.

Wooden roots can be very decorative and therefore I can recommend two types of roots here: Either you use roots that have been in another aquarium for a long time and are really sure, that they do not release any harmful substances such as nitrite into the water. Or you use roots made of the non-toxic Polyrin. Another option is to find your own natural dried wood. I only use pieces of wood, that are bone dry and faded and have been lying around for several years. No algae or fungi should grow on these pieces of wood. If you water such dried wood, it usually sinks after 1-2 days. After successful watering, perching plants such as **Java Moss** or **Java Fern** can be attached to such wooden branches with fishing line and allowed to grow. This gives a very nice visual effect to the aquarium and you have plants that are not too exposed to the vagaries of the crayfish. Stones can be added to almost any aquarium as decorative material without hesitation, if they do not contain any metallic or other harmful inclusions. If the tap water is already very hard, you should avoid using limestones, as they can unnecessarily increase the water hardness. If you lay stones on the sandy bottom, the crayfish have the opportunity to dig hiding places between the stones, just like in nature. Such crevices and cracks later provide numerous hiding places for the crayfish fry. Under no circumstances should the crayfish fry be reared in sterile breeding tanks, as the young animals absolutely need infusoria and other organisms, which they find in the detritus for their healthy development! Excessive hygiene in a crayfish aquarium is therefore more harmful than beneficial. On the one hand, the adults are disturbed by all the "piddling around" in the aquarium, and on the other hand, the fry cannot develop. It is very bad to expose egg-bearing females to stress in any form. This usually causes them to lose their brood! Larger water changes should be carried out depending on the amount of food given and the stocking density. Quantities of 50 - 80% of the aquarium water should be changed,

because smaller changes hardly cause a short-term improvement of the water quality. If you have had deaths in a crayfish aquarium due to moulting problems, you should check the nitrate value and carry out a water change if necessary. Larger water changes should be carried out once or twice a month in heavily stocked aquaria and once a month in lightly stocked aquaria. Because of the crayfish pestilence, European, American or Australian crayfish species should not be kept together.

Different species from one crayfish habitat, which even occur together in nature, should not be put together in the confines of an aquarium, as one species will usually crowd out the other. Such husbandry attempts are only possible and promising in exceptionally large tanks. However, it is possible to keep crayfish together with harmless shrimps, thick-shelled snails, or freshwater mussels. Large crayfish can be kept together very well with dwarf shrimps of the ***Caridina-*** and ***Neocaridina genera***. When socialising with fish of any kind, you should consider from the outset that you cannot treat fish diseases in a crayfish tank with medication, because this can be harmful to the crayfish. Therefore, I recommend at this point to use a UV device that kills the harmful germs. The UV device should always be used in a slightly oversized way so that it produces the optimal effect. This means, for example, that for a 100-litre aquarium you should use a device that is designed for 200 litres. The UV radiation is completely harmless for the animals, as it remains in the device and only disinfects the water. With this method, even a severe infection of the fish with ***Ichthyophtirius multifilis*** can be successfully contained. Veil fin breeds or bottom-oriented fish should better not be put together with crayfish. Crayfish species with long slender claws often tend to grab fish deftly, while species with rounded claw shapes usually do not chase fish. If you associate animals that do not naturally occur in the same habitat, there is no natural predator-prey scheme

here, and keeping them together is usually successful. An example of this would be keeping Australian crayfish together with medium-sized African cichlids from Lake Malawi, with which I have had very good experiences. These should be just a few general care tips and inspirations from many years of experience with keeping and breeding a wide variety of crayfish species. Of course, different species have different husbandry requirements, but I hope that one or the other crayfish keeper or newcomer can benefit from some of my ideas and experiences.

When crayfish clean their eyes, it is always a funny sight. Perhaps this is also the attraction of taking a closer look at these animals.

Nutrition of the crayfish

This *Cherax boesemani* "Red Brick" is gnawing on a piece of dead wood.

In this topic, a fundamental distinction should first be made between keeping crayfish in a pond and keeping them in an aquarium, as the confined space of an aquarium brings other problems with it, than keeping them in a pond. In a pond crayfish usually already find everything they need to live. Which is why they only need to be fed separately in commercially operated aquacultures. Any kind of unsprayed(!) grain, (pre-cooked) carrots, cucumbers and lettuce, as well as feed granules are suitable for this. Crayfish in particular react to chemically contaminated food with unusual behaviour, panic reactions or even an attempt to leave the water. Again and again one encounters the ineradicable prejudice, that crayfish are fish eaters. This is

not true in this form. Crayfish are omnivorous animals, that only eat fish, when they are sick, or if they cannot escape the crayfish in the cramped conditions of an aquarium. Most crayfish like to eat alder, willow and beech leaves, plant material, detritus, algae and small aquatic animals of all kinds. Some crayfish even eat dead wood, like the ***Cherax boesemani*** pictured above. Unfortunately, it is not known whether they eat the wood to absorb fibre, or whether they actually eat it as a complete food. It is important to make sure that the crayfish are fed as varied and also filling a diet as possible to avoid encroaching on moulting conspecifics. Excessive feeding of high-protein foods should be avoided, as some crayfish are otherwise prone to shock moulting. This means, that they moult too early and then die, because its new carapace has not yet developed far enough. For the crayfish I keep, the spirulina-containing herbivore food Tetra Pro Vegetable has proven to be the main food. In addition, I also feed black, white and red mosquito larvae as well as Mysis. I also occasionally feed frozen smelts to my cold-water crayfish. You should rarely feed crayfish with dead fish, as otherwise you could give them too much of a fishy taste, which could then cause the fish to fail in the aquarium.