AARK *EX SITU* MANAGEMENT GUIDELINES:

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BIOLOGY AND FIELD DATA

Taxonomy:

Order: Caudata
Family: Salamandridae
Subfamily:
Genus: *Neuergus*
Species: *Neurergus kaiseri* (Schmidt 1952)
Common names: Emperor spotted newt
Luristan newt
Zagros newt
Iranian harlequin newt

Comments:

Description:

Size: Length: Total length: 10-14 cm

Coloration: On the dorsal surface of adults, a mosaic of white and black patches is shown and there are dorsal orange-red stripes. The belly and legs are coloured with orange-red. There might be however, small black patches on the belly as well. The percentage of black or white coloration varies among individuals, with some being mostly white, mostly black, or anywhere in between. The species has striking color and patterns. The eyes are black.

Morphological characters: The forelimbs have four digits and the rear five. They have no webbing between the digits. The sexes can be differentiated by the anatomy of the cloaca, with the male having an enlarged, rounded cloacal region, and the female having a extended tubular shaped cloaca. However, these differences are clearly visible only during the breeding season. (Sparreboom et al 2000)

Weisrock, et al (2006), recovered Neurergus as the sister taxon of Ommatotriton. Steinfartz et al (2007) suggested on the basis of DNA sequence evidence that Neurergus is the sister taxon of Ommatotriton. When it comes to *N. Kaiseri,* the species shares similar morphology and habit with *Triturus alpestris* (Haller-Probst & Schleich, 1994).

Longevity:

Longevity in the wild is unknown. In captivity the species regulary lives beyond 6-8 years.

Zoogeography/ecology:

Distribution: *N. kaiseri* are endemic to the Zagros Mountains of the Luristan Province in western Iran. They live at an altitude of 750-1200m in highland streams that are surrounded by arid scrubland. The present range is estimated to be less than 10km^2 due to habitat

loss in both terrestrial and aquatic habitats.

Habitat: Terrestrial habitats occupied by *N. kaiseri* include diverse community types encompassing oak-pistachio open woodlands dominated by *Quercus brantti* and *Pistachio* spp in the south-central Zagros. This open woodland grows on various soil types including deep sandy loam soils at the bottom of valleys or gravelly soils at the slopes of steep valleys.

The aquatic habitats occupied by *N. kaiseri* varies considerably. Sometimes the newt is observed in water fringes well away from water currents that are normally covered by clay or sand. The pattern of habitat selection in *N. kaiseri* is characterized by high occurrence in sandy substrates.

In the wild *N. kaiseri* experiences a highly seasonal climate. Winters are cold and summers can be very hot and dry. Water may
be present for just three or four months of the year during winter and they use ponds and pools in addition to streams. Weather conditions
for the approximate area throughout the year is shown below:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temperature	0	0	5	12	17	22	25	26	21	13	6	1
Avg. Max Temperature	3	5	10	17	22	28	31	32	27	20	11	5
Avg. Min Temperature	-3	-3	1	6	11	16	20	20	15	8	2	-1
Avg. Rain Days	2	2	5	6	5	1	1	0	1	3	3	3
Avg. Snow Days	4	3	2	0	0	0	0	0	0	0	0	2

http://www.climate-zone.com/climate/iran/celsius/tabriz.htm)

Population: Estimated to be less than 1000 adults in the wild (www.iucn.org, www.caudata.org)

Status: The species is listed as Critically endangered (CR) in the IUCN Red List of threatened species (2008) due to habitat fragmentation and destruction, overcollecting and being used as a pet in the Iranian as well as foreign pet shops

The Global Amphibian Assessment cites the following evidence: "its extent of occurrence is less than 100 km^2, its area of occupancy is
less than 10 km^2, its populations are severely fragmented, and there is a continuing decline in the extent and quality of its habitat, as well
as a decline in the number of mature individuals due to overharvesting for the illegal pet trade".

The newts of Zagros Mountains, especially the genus *Neurergus*, are extremely sensitive to environmental change because they live in marginal conditions (www.open.ac.uk/daptf/froglog/FROGLOG-56-2.html).

Habitat loss is a result of wood extraction for small-scale subsistence use. There have also been recent severe droughts and damming of the few known inhabited streams. Some of the small streams (serving as breeding sites) have dried out due to the severe drought of recent years. Populations previously occurring in these areas have been extirpated. Water contamination (either from human disposal, where the habitats are close to villages or small

townships, or by chemical pollutants such as fertilizers, insecticides and herbicides) may also be having an effect on reproductive success and on various life stages (http://www.open.ac.uk/daptf/froglog/FROGLOG-56-2.html).
A further major threat is overharvesting of mature individuals for the illegal pet-trade. As said before, it is estimated that fewer that 1000 mature individuals exists today. The species may also face other un-quantified threats like chytrid fungus and iridoviruses that have spread rapidly in other regions of the world with horrifying consequences (Chinchar, V.G 2002, Wright and Whitaker 2001).
Neurergus kaiseri may also be affected by climate change (Carey and Alexander 2003).

Diet:

A wide variety of suitable-sized invertebrates.

Reproduction:

Sexual maturity/age at first breeding:
N. kaiseri reach breeding size at 2-3 years of age.

Seasonality:
Although no information is available regarding wintering activity of *Neurergus kaiseri* in its Iranian range, the appearance of the animal in early spring and disappearance in summer implies that this newt requires both upland and wetland habitat that contain suitable aquatic environment during the breeding season and subterranean burrows appropriate for aestivating and over-wintering. The appearance of *N. kaiseri* in early spring (Late march-Early April) and their disappearance in summer (from late June-July) suggests that this taxon is dependent on both terrestrial and aquatic habitats (further investigation needed to reveal the exact proportion of aquatic and terrestrial life, pers. comm).

Eggs/oviposition/clutch size/ development:
In the breeding season, courtship takes place in the water. Females of *N. kaiseri* are recognized from males based on their swollen bodies, indicating presence of enlarged ovarian follicles as well as the flat shape of the cloaca. Eggs are laid singly or in small clumps on aquatic vegetation or on rocks (pers comm). After a few weeks, the larvae are found in the water and it takes about 2 months for the larvae to complete metamorphosis (http://www.open.ac.uk/daptf/froglog/FROGLOG-56-2.html).

Activity and other notable behaviour:

N. kaiseri utilise still ponds for reproduction. Outside of the breeding season, *Neurergus* typically remain terrestrial.

Unlike the other *Neurergus* species, *N. kaiseri* have been observed breeding in stagnant pond-type environments. Although they inhabit still water in the wild, captive breeding has generally taken place in aquariums that have some gentle water flow.

The following is a summary of results obtained by Sparreboom et al., 2000, and should be viewed as a general guide to breeding behaviour.

"The courtship behaviour of *Neurergus* is similar for all four species, and resembles that of some *Triturus* species, e *T. alpestris*. The resemblance applies especially to *N. kaiseri*. *N. crocatus, N. strauchii,* and *N. microspilotus* will actively pursue females and attempt to block their path, while pursuit is limited in *N. kaiseri*. *N. microspilotus* males survey their surroundings from an elevated spot, and return there after unsuccessful pursuits. Tail

fanning is observed in all four species, which consists of the male folding the tail along the side of the body and undulating the entire tail, or only the distal portion, usually while standing perpendicular to the female. Males may fan from either the left or right side. The amplitude of the fan is smallest in *N. kaiseri*. There is a noticeable difference in the duration of fanning bouts between *N. strauchii* and *N. crocatus*, with those of *N. crocatus* being longer in duration than *N. strauchii*. After a period, the male will attempt to lead the female off by creeping in front of her, while undulating a slightly raised tail. A responsive female will follow, occasionally undulating her tail. Shortly thereafter, the male deposits a spermatophore and leads the female over it, at which point he pivots 90° to a perpendicular position. This is commonly known as the "brake", and effectively stops the female's progression such that her cloaca is just over the spermatophore. Competing males of *N. strauchii* may interrupt a courtship display in progress, thus assuming the courting position. Females of *N. strauchii* and *N. crocatus* deposit eggs on the undersides of flat rocks, while *N. microspilotus* opt for crevices or hollows of stones. *N. kaiseri* females deposit eggs on shaded, rough surfaces, including, but not restricted to the undersides of stones."

The streams and ponds inhabited by these newts are mostly surrounded by very arid scrubland. The newts require relatively complex mosaic landscapes that include terrestrial elements for foraging, protection and hibernation as well as aquatic habitats with good quality and a rich invertebrate food base. Connective habitats that enable migration between terrestrial and aquatic habitats are also important determinants of population size and abundance (www.globalamphibians.org). The aquatic habitat of the *Neurergus* newts is closely related to shallow, cool, clear mountain streams and nearby vegetation (Baloutchi and Kami 1995).

MAINTENANCE IN CAPTIVITY

Accommodation

Adult animals:

Enclosure design: Depending on whether a "natural" looking set up is required, as would be preferred for a
public exhibit, or a "laboratory" one, for ease of maintenance in an off-show breeding set up or even a bio-secure set-up, many different materials can be utilised:

"Natural" method

The housing needs of *N. kaiseri* are similar to those of other newts that migrate seasonally between land and water. When kept aquatic, most keepers opt for a large semi-aquatic setup containing plenty of rocks and hides, both above and below water. Water level need not be too deep, with levels of 20-30 cm (8-12in) being typical. It is unclear whether or not these animals utilize swiftly-moving water in the wild. Thus the filter should produce no more than gentle movement of the water in the tank. Some suggest that a simple aquarium with gravel on the bottom (app.1,5 cm deep) and limestone pieces as hiding places works nicely. Java moss can be used for egg laying.
Suggested enclosure dimensions: 50x30x30 cm for 4 adults. No additional humidity or rainfall is required. In most European countries a normal photoperiod of natural daylight is reported to be enough and certain keepers have reported –ve phototaxis by adults.

For periods of terrestrial housing, most keepers opt for a soil-based substrate kept on the dry-side. The enclosure should be furnished with plenty of stacked rocks or bark. Environments for this species do not need to be misted and excess moisture may be detrimental. It is recommended that a moisture gradient be provided in the soil by adding water to only one end of the enclosure. A shallow water bowl provides insurance against drying out and the animals will often use it. The crevices between the pieces of rock or bark

provide the animals with a full range of moisture options and hiding places. Bricks with holes in them are also very appropriate, for both aquatic and terrestrial habitats.

Appropriate housing for *N. kaiseri* during the summer months is a much-debated topic. In the wild, to the best of our knowledge, these animals spend the summer in hot dry habitat with little or no access to water. Their water source normally dries up and they have no choice but to aestivate for many months on land. Thus, many keepers believe that it is important to keep the animals fully terrestrial outside of the breeding season. Some believe that it is important to replicate their normal yearly cycle as closely as possible and that the terrestrial phase helps to prepare the animals for breeding. In contrast, other keepers report successful housing and breeding of animals that have been kept fully aquatic all year round. However, not enough reproductions have been reported to say conclusively what effect terrestrial versus aquatic housing has on breeding in the long-term. In most cases, *N. kaiseri* never "choose" to move from the water to the land portion of the tank at any time. This is in contrast to some newt species, such as *Triturus*, in which most adults will voluntarily move to the land portion of the tank in summer (www.caudata.org).

"Laboratory" and bio-secure methods

The "laboratory set-up should not differ too much from the natural one in terms of climatic and physical environment offered. However a more 'sterile' and easily maintained range of materials can easily be incorporated.

Bio-secure methods

These standards are based upon those reported in the proceedings of the *CBSG/WAZA Amphibian Ex situ Conservation Planning Workshop, El Valle, Panama, 12-15th February 2006*. Which standard that should be recommended for *N. kaiseri* in the future, is too early too say even if EAZA amphibian list recommends both conservation and education activities. Better safe than sorry when it comes to management?

Ex situ breeding of selected amphibian species is recognised as an essential and integral part of the IUCN Amphibian Conservation Action Plan to stem the loss of amphibian species worldwide. However, the emergence of the infectious disease chytridiomycosis (caused by the fungus *Batrachochytrium dendrobatidis*) as a significant factor in the recent decline and extinction of many amphibian species, raises specific challenges for *ex situ* conservation. Additionally, the difficulty and expense involved in reliably testing amphibians for this disease means that it may often go undetected for extended periods of time and even re-emerge in animals thought to be negative.

Therefore, the safest and most responsible way to proceed with the keeping of all amphibians in captivity is to treat all animals as *potentially* infected (with chytrid and/or other pathogens) and avoid the discharge of potentially infectious water and other materials into the environment (where they may infect local native amphibian populations). Furthermore, increasing awareness of biosecurity issues and introducing a quarantine-like approach to amphibian husbandry of enclosures/rooms within an institution and between institutions will significantly reduce the risk of an epidemic outbreak of chytridiomycosis (or other disease) in captivity.

Attempting to screen for and treat, known and unknown diseases is no substitute for bio-security – i.e. implementing strict and thorough quarantine and maintaining high levels of barrier management (CBSG/WAZA Amphibian Ex situ Conservation Planning Workshop, 2006).

Biosecurity and husbandry standards can be divided into three categories based on the intended Role of the animals in captivity.

Basic
Specimens maintained *ex situ* for **Educational*** purposes with no requirement for research and no prospect of release to the wild.

BIOSECURITY

- Separate footwear per room and/or footbaths at entry/exit.
- Treatment/decontamination of **all** waste water from enclosures and rooms housing amphibians prior to discharge/disposal (addition of household bleach at ratio 1:10 by volume).
- Incineration (or disinfection by means of suitable chemicals, heating to 70°C for 25mins, or complete desiccation) of all amphibian enclosure waste – soil, leaves, plants, furnishings, food items, faeces, bodies (after post-mortem examination).
- Escape-proof housing of a size appropriate for species.
- Pest-proof housing (rodents, cockroaches, ants, etc) to prevent pathogen transfer, predation of amphibians, and escape of food insects.
- Water free of pathogens and chemical contaminants.

HUSBANDRY

- Regular water changes – automated or manual.
- Appropriate cage furnishings wherever necessary.
- Exposure to natural light (or good artificial equivalent) if exposure is normal in natural history of the species.
- Appropriate temperature/humidity for natural history of the species.
- Appropriate food, dependent on species – with supplementation (vitamin/mineral).

Intermediate
Specimens maintained *ex situ* for **Conservation Research*** purposes with no prospect of release to the wild.

All Basic standards, but also:

BIOSECURITY

- Individual instruments (tongs, nets, bowls, tanks, pumps, filters etc) per enclosure and/or species.
- Change gloves (non-powdered) for each enclosure.
- Design of enclosure should minimize keeper/animal contact.
- Maximize use of automation in water quality maintenance/watering.
- Maintain a consistent/directional flow of husbandry routine – from low risk and high importance species/individuals to high risk and lower importance species/individuals.

HUSBANDRY

- Climatic conditions (lighting, photoperiod, temperature, rainfall, humidity, etc) should follow the natural cycle for the species and be automated wherever possible.
- Highest level of record-keeping.

Advanced
Specimens maintained *ex situ* for conservation breeding purposes **(Ark/Rescue/Supplementation)*** with the ultimate expectation of release to the wild.

All Basic and Intermediate standards, but also:

BIOSECURITY

- One species or local assemblage of species per room/unit – a state of *permanent quarantine.*
- Separate uniforms/overalls per room (stays in room unless disposable).
- Food coming from known and trusted source; 3-month period of familiarization with natural food types recommended prior to any release.
- Pre-release, monitor condition of specimens to determine fitness for release – thorough health screening including; regular and frequent PCR screening for chytrid fungus over several months; screening for *Ranavirus*; regular bacteriological and parasitological screening; and thorough necropsy and histological examination of deceased animals and a representative subset of the intended release animals – see *Pessier, A. P. (In press): Management of disease as a threat to amphibian conservation. International Zoo Yearbook, 42*, for a comprehensive overview of amphibian health screening needs.

Recent metamorphs:

90x50x40 cm aquarium adequate for about 70 youngsters; aquarium filter was needed for such a density of animals.
Limestone pieces as hiding places, no gravel. 12/12 hours photoperiod.

Larvae:

Plastic tanks of different size. No furniture necessary – but may be beneficial. It is possible to keep the juveniles in water all the time, if they have a place where they can stay just at water level to prevent drowning during metamorphosis. There are also experience of raising juveniles in a more terrestrial setting. Either way is reported to work fine, but the juveniles that are raised aquatic seems to grow faster (pers. comm)

Life-support details:

Temperatures of between 15-25°C (60-68°F) are appropriate, although this species can tolerate temperatures up to 30°C (86°F) when housed on land. During winter, terrestrial animals have been taken down to near-freezing temperature without ill effect, although this is not recommended due to the risk of freezing. Even at temperatures approaching freezing, the animals remain active and feed. A cold (5-10°C; 40-50°F) terrestrial period in late autumn and early winter seems to stimulate breeding, as is the case for *N. strauchii*. See Reproduction section for more details.

Diet

Food items:

Adult, during terrestrial period: *Chironomus* sp., Enchytraeidae (white worms), crickets and cockroaches of appropriate size, earthworms (whole or chopped), lesser wax worms, large fruit flies, maggots, tropical woodlice.

Adult, during aquatic period: the usual assortment of newt foods such as earthworms, live/frozen bloodworms, etc. They are not picky eaters.

Recent metamorphs and juveniles: *Chironomus* sp., Enchytraeidae (white worms).

Larvae: *Daphnia*, *Artemia salina*, *Gammarus*, chopped white worms as they grow large enough. It is important to feed the larvae *Daphnia*, *Gammarus* or other crustaceans in order for them to develop the species' normal orange-red coloration after metamorphosis.

Feeding method:

Adults: Just put the food into water, usually in the evening.

Larvae: The same as adults.

Reproduction

Social structure:

Breeding groups of 1.3 are recommended.

Temperature manipulations:

Although the native habitat of *N. kaiseri* is generally hotter than that of the other *Neurergus*, most successful captive reproductions have been achieved under conditions nearly identical to those used for *N. strauchii*.
Sparreboom et al. 2000 reported courtship behaviour after a winter cooling at 17°C and introduction of the animals into water in February.
However, Bogaerts reports that he was unable to breed them under these conditions; the females were pregnant, but the males did not come into breeding condition. Better success was achieved when the animals were kept below 10°C (50°F) for a few weeks.
Alan Cann has had breeding success with a winter cooling period at 8-15°C (46-59°F).
Most breeders keep the animals in a place where they receive natural light or artificial light that mimics the natural photoperiod. For animals that are cooled under terrestrial conditions, the animals should be warmed up to spawning temperatures slowly, over several days.
Feed generously and allow them to enter the water for spawning when they are ready. They will usually enter the water very quickly
(www.caudata.org).

Other breeders report that the animals stay aquatic year-round, with temperatures in winter from 6-12C. They lay a few eggs at these low temperatures as well (they start in late November), but increase output dramatically as the temperatures rise for spring (generally late February) (pers. comm.).

Courtship and spawning:

Males “dance” around females, spawning usually later. Females stick eggs to substrate (e.g. Java moss). Eggs were laid during 3 months (not sure it was the same female all the time, pers comm).

Care of eggs and larvae:

Eggs:

N. kaiseri eggs are larger than the eggs of other *Neurergus* species. In nature eggs are deposited singly on rough surfaces. Unlike other *Neurergus*, which ordinarily lay eggs on the underside of stones*, N. kaiseri* also use vegetation for laying their eggs. The eggs are laid away from light, but not always on the underside of stones.

In captivity, eggs are deposited in many different locations in the tank - on stones, rocks, plants, glass - and many are laid in illuminated areas The eggs can be moved to another tank. Methylene blue is recommended for disinfection if necessary but most eggs develop successfully without disinfection.

Eggs are normally incubated at a similar temperature to that at which they were laid. The larvae are easy to raise and do not ordinarily encounter problems.

Larvae:

Larvaes can without problem be raised in water temperature down to 10°c and they are still eating a little bit.

Experiences in breeding and raising this specie is very small for the moment, many breeders try different way to do it and it seems to works well. First conclusions about N kaiseri is that the breeding and raising are not very difficult and they are strong juveniles and easy eaters.

Larvae should be moved to plastic tanks after hatching, water level in the tanks from 5 to 40 cm (no difference observed). Water changed depending of the density and food type, usually 1-2 times a week up to 100%. Temperature from 17.5 to 24C, an average 21°C. Tadpoles are best housed communally with their clutch-mates. The larvae are easy to raise and do not ordinarily encounter problems. It is important to feed the larvae *Daphnia*, *Gammarus* or other crustaceans in order for them to develop the species' normal orange-red coloration after metamorphosis. Metamorphosis can be slow, with the juveniles sometimes attaining adult coloration before loosing their gills.

After 2 months, it is wise to keep max 6 tadpoles per tank. Keep them all the time in water but with Java moss and change water each or second weeks max. The water level should only be 4, 5 cm. Add some bark or small terrestrial items at the metamorphose, otherwise drowning might be a risk (pers. comm.).

At metamorphosis the animals may move to land. Juveniles can be raised in terrestrial setups, arranged as described above. Bogaerts also reports raising them in an aqua-terrarium without problems. Even if they are kept terrestrially they will often enter water to search for food. Juveniles are generally robust and hardy, with very good appetites. They can grow very quickly, with well-fed juveniles doubling in size in only a few months (www.caudata.org).

Other details:

Handling and transport:

The animals should be handled with great care and wet, gloved hands.
When being transported they should be packed into plastic cartons with sufficient air holes, the type used for invertebrate live food are ideal, and cushioned with damp moss or damp toxin free paper tissues. This is to prevent desiccation and injury during transport.
All transportation should conform to the Welfare of Animals during Transport Order 1994, and IATA
regulations if being transported by air. An 'Animal Transport Certificate' should accompany the animals
during their journey and their containers should in no way compromise their welfare.

Population management:

To be determined from Taxon Management Plan

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