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FIELD SURVEYS AND COLLECTION MANAGEMENT AS BASIS FOR HERPETODIVERSITY RESEARCH AND NATURE CONSERVATION IN VIETNAM

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Introduction

The systematic study of biodiversity is an important requirement for its long-term preservation. First of all, the species and species communities of a natural habitat have to be documented for consecutively understanding their interactions and ecology. And the compilation of the species' specific requirements in turn is the basic prerequisite for their conservation and for the preservation of the wildlife habitat. In short: We can only protect, what is well known to us.

It is the major role of the natural history museums, to document and investigate species diversity in a worldwide scale. Their collections, sometimes being compiled over a long period, enable diverse systematic, ecological and thus also nature conservation related studies; due to their possibilities of comparison they also allow a safe determination of newly collected specimens or collections. The interplay of old and new collections additionally enables conclusions of altering faunal compositions over a long period, either due to natural or human impacts.

Beyond dispute, the biological diversity is heavily threatened, e.g., by habitat destruction, deforestation, wildlife trade and further severe human impacts; thus, it is self-evident that especially the collection of vertebrates is only possible these days in a selective and responsible manner and as a matter of course with appropriate permissions, taking existing international and national laws, directives and instructions into account (e.g., CITES, Animal Welfare Law, Law of Forest Protection and Development, Governmental Decree 59/2005/ND-CP from 4 May 2005, 32/2006/ND-CP from 30 March 2006). However, after Henle & Veith (1997), collecting in principle may only represent a serious threat for the survival of amphibian and reptilian species under highly limited general conditions; viz. for the few species with a limited reproduction rate and a limited range as well as for the local survival of small populations of other species (Ehmann & Cogger 1985, Henle & Streit 1990).

The collecting of at least certain species or species complexes is indispensable for the compilation of species lists, because the exact investigation of preserved specimens, in part only in consideration of modern research methods, principally allows an accurate determination. In addition, the subsequently compiled species lists and field guides often are the impetus for future protection measures (see also Stuebing 1998). Especially the collection of rare, threatened, formerly not yet recorded or even new species, which may subsequently serve as flagship species, serves to improve or even to encourage a conservation status. Furthermore, the type procedure of the ICZN (2000) prescribes that species (or subspecies) are characterized by scientific names that have to be linked to a single individual, the so called objective name-bearer or (primary) type, which is the sole objective basis for this specific name.

Because the study of Vietnams amphibian and reptilian fauna is the main research of the author, a short overview of collection-based herpetological research is given in the following, i.e., arranging fieldwork, collecting and evaluating data, and designing and developing collections; for more detailed insights see, for example, Heyer et al. (1994) and Simmons (2002).

The herpetofauna of the Phong Nha – Ke Bang National Park: an example for diversity research and conservation in Vietnam

On the way towards a centre of nature conservation, the Cologne Zoo (Germany) does not only keep and breed endangered species but also engages in conservation and research projects in their countries of origin. Since 1999 the Cologne Zoo engages in a German-Vietnamese cooperation project concerning nature conservation and biodiversity research in a unique karst forest area in the Truong Son of central Vietnam, the Phong Nha Nature Reserve. In the meantime this protected area has been extended to the Phong Nha - Ke Bang National Park, which was recently declared by the UNESCO as world heritage site. This region is part of the central Indochina limestone, stretching along the Lao-Vietnamese border and forming one of the largest ranges of contiguous limestone karst in Indochina. As basis for protection and conservation, the biodiversity research is one of our most important project aspects besides forest protection (e.g., improvement of the rangers work), supervising a rescue centre for confiscated animals, and, in cooperation with the Frankfurt Zoological Society, the reintroduction of endangered primate species. We have especially focused on the investigation of the local amphibian and reptilian fauna for ten years, because they serve as suitable bio-indicators. Seven years ago, we published a first, preliminary list of the areas herpetodiversity, based on own fieldwork and first Vietnamese reports, comprising 96 amphibian and reptilian species (Ziegler & Herrmann 2000). Some years later, we could bring the total number of amphibians and reptiles known for the area as a result of further field work to 128 species (Ziegler et al. 2004), of which approximately 20% were listed in the Red Data Book of Vietnam. In a recently published list (Ziegler et al. 2006), the total number of the herpetofauna known from the National Park was brought to 140 species, representing more than 30 percent of the 458 amphibian and reptilian species listed in the updated checklist for Vietnam by Nguyen et al. (2005).

However, we are still far away from having the National Parks herpetodiversity completely inventoried, which is impressively demonstrated by further new records and even further new species discoveries being currently processed by us. Whereas spectacular discoveries such as the pitviper *Triceratolepidophis sieversorum*, which represented both a new species and genus (Ziegler et al. 2000), are relatively easy discernible as a distinct taxon, the recognition of so called cryptic species is much more complicated. Such species extremely resemble each other by external morphology and only in-depth investigations based on the collected specimens may enable a proper identification. For instance, the discovery of the skink species *Lygosoma boehmei* from Phong Nha – Ke Bang (Ziegler et al. 2007b) clarifies how important collecting can be. Externally, this lizard fairly resembles *L. carinatum* which is only known from a more southern location in Vietnam. It was the counting of scalation data which showed us that a new species must be involved, which would not have been recognized by a photographic record alone. For a better distinguishing of cryptic species, we further recommend to use modern research methods. One example for anurans are bioacoustic studies, viz. the recording of the species' specific male advertisement calls to distinguish externally similar species; furthermore, molecular analyses are very helpful to reconstruct the phylogenetic relations of species based on blood or tissue samples obtained from field collections. By means of morphological and in part also molecular research, we discovered and described not less than 14 new amphibian, reptilian and mammal species from the two close by provinces of Quang Binh (i.e., Phong Nha – Ke Bang National Park) and Ha Tinh (i.e., Ke Go Nature Reserve) throughout the last decade. Without collecting, their existence would still remain unidentified and no special protection measures would be available. In addition, it must be recognized, that newly discovered and attractive species may serve as so called flag ship species, which are of great importance for local and in part also international nature conservation measures. They further encourage the pride of the local people and motivate to engage in conservation measures. For this reason, we named a large and attractive new bent-toed gecko species after the National Park as *Cyrtodactylus phongnhakebangensis* (Ziegler et al. 2002). In terms of benefiting the local people, we also investigated the components and effectiveness of the venom of the newly discovered pitviper *T. sieversorum* (Mebs et al. 2003).

Comprehensive field collections like that from Ke Go Nature Reserve (Ziegler 2002) are also important sources for a better understanding of local species communities and especially for the understanding of specific ecological requirements. By means of dissecting collected specimens, analyses of the gonads give insights into the reproductive biology, and stomach and gut content analyses contribute to a better understanding of the trophic niche. In addition, if series of adult and subadult specimens of a certain species are available, character variation studies are of great importance, because it is essential for a taxonomist to know about the differences between intraspecific variation and interspecific distinctions. Therefore, it has to be taken into consideration for the composition of a museum collection, that not only local collections are available for comprehensive comparisons, but also collections of at least adjoining areas or countries.

After their discovery, new species are often recorded from other localities too and new species' records help to close distribution gaps due to a previously inadequate exploration. For instance, we recorded the horned pitviper *Protobothrops cornutus*, that previously was only known from few specimens from northern Vietnam, for the first time for the Phong Nha – Ke Bang National Park (Herrmann et al. 2004). The species had not been reported

for more than half a century and was already believed to be extinct. Its rediscovery in the Phong Nha – Ke Bang region is one more reason to enforce the protection of that karst forest habitat. Additionally, this record raises hope that further forested areas in central and northern Vietnam could be located in the future, which are also inhabited by this enigmatic species. A similar case was the recent discovery of the crocodile lizard (*Shinisaurus crocodilurus*) in Vietnam, which actually represented a new country record (Le & Ziegler 2003). The Vietnamese record of this endangered species, that is listed under CITES Appendix II, and which was formerly only known from few southern Chinese provinces, argues for the probability of further future records in the Vietnamese-Chinese border area, which could initiate enhanced or even new protection measures or nature reserves.

While recording biodiversity, not only the species numbers but also their frequency is of importance. By reason of our long term research in Phong Nha – Ke Bang we recently could provide a first frequency study in snakes, which is to our knowledge the first one available for Vietnam (Ziegler et al. 2007a). Namely, it is the species frequency and density which allow conclusions of rarity, threats or population fluctuations. In addition, we provided a contemporary determination key for the snakes of central Vietnam, because keys are important documents for rangers, but also for authorities as for example the custom. If at all, mostly old or only general keys are available, inhibiting proper identifications, which is the basic requirement to distinguish unprotected from protected species.

Furthermore, in times of the global amphibian crisis, another important exploratory focus in Phong Nha – Ke Bang is not only the registration of adult amphibians but also of their larval stages. The morphology and ecology especially of tadpoles are poorly known and data of ecological requirements and interactions are mostly lacking, however, which fundamentally differ from that of adults and therefore are important for conservation purposes. Hence, we allocate tadpoles and adults by means of molecular comparisons. With the subsequent larval descriptions (e.g., Ziegler & Vences 2002, Hendrix et al. 2007) we intend to provide a basis for continuative ecological studies and consecutive protection measures. In general, molecular analyses can help to enlighten the actual systematic relationships of frogs and affiliated tadpoles. DNA sequences, if deposited in public databases, provide unambiguous means to assign the larvae to adult stages, even after taxonomic re-definitions and rearrangements. They therefore provide substantial contributions to future works on larval morphology, sibling species complexes and different ecological niche occupations in amphibians.

Collecting amphibian and reptilian species

To begin with the short manual of how to collect and prepare amphibians and reptiles, it must be again underlined, that every field herpetologist has to read up on the required permissions and legal regulations. Beyond it has to be taken into account that the below-mentioned chemicals and narcotics can be harmful to man and / or being inflammable (check for fire preventions, contingency plan etc.).

The subsequent instructions derive from own experience values or are from the overview papers of Thorns (1988) or Piechocki & Altner (1998). In addition, I have only treated the

buildup of a scientific museum collection; for the taxidermy for public exhibitions see., e.g., Paulduro (1988), Thorns (1988), and Piechocki & Altner (1998).

Amphibians

Amphibians are subdivided into three groups (orders), viz. the anurans (Anura), the salamanders and newts (Caudata), and the only barely known caecilians (Gymnophiona). The latter ones are elongated, worm-like and limbless amphibians, which usually are fossorial or aquatic. Normally they are only accidentally found during clearing and building work. All amphibians have a naked skin with mucous glands, and are usually adapted to humid environments. Most of the species are active at night and hidden during daytime.

The easiest way to find amphibians is to search nearby watercourses throughout the mating and spawning season, because also terrestrial amphibians can be found during this period close to or in the water. At that time, also sexes are easiest to distinguish, due to the development of secondary sex characters such as vocal sacs and nuptial pads in numerous male anurans or an intensive mating coloration and / or dorsal crests in male newts. Also the swollen cloacal lips are a useful feature to distinguish male salamanders and newts from females. Semiaquatic or aquatic amphibians are best caught with a not to coarsely meshed dip net, which should be collapsible for the transport. The watercourse should not only be screened at the surface of the water but also on the ground and in the marginal areas, often covered by vegetation. Most anuran species are mating nearby water courses at dawn and night, especially after and during rains. Due to their advertisement calls, it is relatively easy to localize the approximate position of male anurans, which subsequently can be located with a hand or head torch and caught by hand or with a small dip net. For different types of traps (e.g., drift fences, pitfall traps, light traps) see amongst others Heyer et al. (1994), and Henle & Veith (1997). Nocturnal amphibians can be discovered during daytime at their hiding places, for example in humid burrows, in leaf litter, or by turning stones, roots or logs and in inspecting small waterbodies such as water filled knotholes or rock pools). Depending from the geographic distribution, some amphibian species aestivate or hibernate in climatic stable shelters. Development stages of amphibians, i.e. eggs and larvae, can be found in or close to water bodies or at humid places in their environment. Some species deposit their eggs around watercourses, for example the foam nests of rhacophorid tree frogs, which can be found on the ground or between leaves in shrubs and trees. However, a proper identification especially of early developmental stages is rarely possible, unless the spawning parents have been identified in advance. Otherwise, larvae must provisionally be kept and reared in water filled buckets or (better) in aquaria for a subsequent identification, or larval tissue samples have to be collected for a subsequent molecular allocation of the developmental stage with adult frogs. However, in the latter case also syntopically occurring adult frogs have to be collected for subsequent molecular comparisons.

In the course of the rapidly world-wide dispersing chitrid fungus (*Batrachochytrium dendrobatidis*), which can be fatal for amphibians, it should be kept in mind that rigorous hygiene has to be carried out while catching and handling amphibians. As far as possible, gloves should be used and a disinfection of equipment and clothes with 70% ethanol or 0.4-1% sodium hypochlorite solution should take place before leaving the biotope; utilized

solutions should be professionally decontaminated thereafter. For the transport and the housing of caught specimens it is important to mind that specimens do not desiccate. Wet linen bags or plastic vessels with small air holes are suitable for a short-dated transport. The vessels should not be overstaffed and their bottom should be covered with wet moss or a similar substrate. If photographs have not been taken in the biotope, photographs should be made up now because the live coloration and pattern is rather important for a proper identification. It has to be taken into account, that the coloration may change between activity phase and recovery or between day and night.

Subsequently, animals should be competently anaesthetized and euthanized as soon as possible, to prevent animals from unnecessary stress. In aquatic amphibians, an anaesthetic is instilled into the water with a pipette, which will be lethal in a higher dose. Piechocki & Altner (1998) recommend acetone chloroform or chloretone (addition of an at least 0.5-1% aqueous solution), nicotin (addition of 4 ml 5% aqueous nicotin solution to 100 ml water), ethanol (addition of 95% ethanol to water in a ratio of 1:10), nipasol sodium (addition of 0.5% buffered solution in drops to water), or novocain (1-4% solution for larvae, 5-10% solution for adults). A closed vessel with a piece of cotton wool containing chloroform, aether or a blend of chloroform and ethyl acetate are suitable for the anaesthetizing and subsequent euthanization of terrestrial amphibians (Thorns 1988). The most efficient method for killing adult amphibians is according to Heyer et al. (1994) to immerse them in a solution of chloretone. Such a solution is made by dissolving a small amount (one teaspoon) of hydrous chlorobutanol crystals in a liter of water.

In former times, amphibians were fixed and preserved in formalin. In the framework of field excursions, it is practical to use formalin, because only small amounts of 40% formalin have to be transported which subsequently can be attenuated in the field with water to a 4% solution to have sufficient amounts of preservation liquid available. However, a formalin fixation causes a nigrification of the coloration and pattern in amphibian and reptilian species. Further unwanted secondary effects are the hardening of the tissue and the decalcification of the bones, which potentially interferes subsequently manufactured skeleton preparations (Böhme 2003). In addition, formalin is harmful to man and tissue which was in contact with formalin even for a short time will not longer or only with great efforts be useful for subsequent molecular analyses. Hence, amphibians are nowadays both fixed and long-term preserved in ethanol. Whereas a long-term preservation is guaranteed with 70% ethanol, animals have to be transferred into a diluted ethanol solution for the fixation process. By using ascending stages from about 40% to 70% ethanol, a too rapid ullage, which would cause a hardening of the animals, is prevented. The time of the different fixation stages depends from the specimen size and thickness, and may last from few hours to several days. Only specimens that are still flexible after the fixation process subsequently facilitate a proper determination and are acceptable collection specimens as well. In the latter case it is also important to arrange the specimens in a natural and appealing position during the fixation. To quicken the fixation process especially in larger specimens, ethanol can be injected through the cloaca opening. Nevertheless, a perfect ethanol-fixation is difficult to convert in larval stages, wherefore tadpoles are still fixed in 4% formalin, but are long-term preserved in 70% ethanol or a blend of 70% ethanol with 4% formalin. An injection is not required for small larval stages at least. The tadpoles should be anaesthetized in a faint ethanol solution before fixation. For research designs for quantitative amphibian studies and standard techniques for inventory and monitoring see Heyer et al. (1994) and Henle & Veith (1997).

Reptiles

The scaly skin is shared by all reptiles. Reptilian groups are the Squamata (amphisbaenians, lizards and snakes), the Sphenodontida (tuataras), the Testudines (turtles), and the Crocodilia (crocodiles). However, the latter are due to some derived (synapomorphic) characters closer related to birds than to any other reptilian group. Reptiles lay eggs (oviparous) ore are viviparous (ovoviviparous or viviparous). Like amphibians, reptiles are poikilothermic, viz. the blood heat depends from the ambient temperature.

Hypothermic reptiles are relatively lethargic and uncoordinated, but warmed-up specimens can be very agile in their activity phase and therefore difficult to catch. Due to the agility of many species and their quick capacity of reaction, field herpetologists should be well informed about habitat conditions and the specific behaviour. Diurnal species are caught at best in the morning hours, when the reptiles leave their hiding places to bask in the first sunrays. Nocturnal species can be found during daytime at their hiding places, viz. in caves, in rock crevices, in the leaf litter, and under stones, logs or bark; to catch nocturnal species during their activity phase it is necessary to inspect the specific habitats with the help of hand and head torches. At cooler temperatures, nocturnal snakes often are found on heat storing road surfaces. In addition, to scan roads or streets for road kills by walking or slowly driving along is always promising. Due to their stable scaled skin, reptilian road kills usually still provide for valuable collection vouchers. By the way, even the moulted snake skin (the so called snake slough) is an important document, which often can be identified due to its still discernible, specific scalation characters. In the cone of light, nocturnal reptiles are easy to detect due to the dazzling and reflecting of their skin. Crocodiles that float at night on the water surface are well recognizable also from greater distances by their reflecting eyes. Small semi- or aquatic species may be caught with dip nets. For catching water turtles, also nets, weirs, or fishing rods with lures are useful. The capture of reptiles usually is done by hand, whereas it is recommended to act with caution in lizards which are able to discard the tail (the so called automutilation). Fast reptiles can be caught with a dip net or with a noose attached to a long stick or a fishing rod. An anteriorly bifurcated branch, noose-sticks, snake hooks or forceps are especially useful for the fixation and capture of dangerous lizards and snakes. In addition, long tweezers are helpful to grasp lizards and snakes that are hidden in deep rock crevices. Smaller crocodiles can be caught from a boat with a long stick with a stable noose. In addition, there are numerous traps for certain species or ecotypes available (e.g., Ziegler 1999), and especially drift fences or pitfall traps are useful to record not only species numbers but also frequencies (e.g., Heyer et al. 1994).

The transport of reptiles should be carried out in thin or massive linen bags (depending from the animals size), which should be tied up at their top. Linen bags facilitate a circulation of air and protect the reptiles from overheating. It is self-explanatory that linen bags containing an animal should not be deposited in the blazing sun. While handling linen bags with venomous snakes it must be considered that they may bite through the linen stuff and it is recommended to act with extreme caution.
The anaesthetization and subsequent euthanazation happens the same way as was described for terrestrial amphibians, at best with ethyl acetate or with a 1:1 blend of

chloroform and ethyl acetate. While blending the liquids, ethyl acetate has to be slowly instilled to prevent overheating. 2-10 ml of this blend is added to a piece of cotton wool which is subsequently thrown in a lockable vessel containing the animal. After the complete unconsciousness and the subsequent passing away of the animal, it should be soon removed, because the chemicals impact on the distortion of the animal by muscle contractions and produce absolute stiffness after longer exposure. Further possibilities of anaesthetizing and euthanazation of reptiles are discussed in Piechocki & Altner (1998).

For fixation, reptiles are transferred into absolute ethanol and subsequently must be arranged in a natural position. Because the reptile skin is to a much lesser extent permeable than in amphibians, we recommend, except for very small specimens, to inject ethanol with a hypodermic needle into the body cavity to prevent internal rotting processes. Injections have to be effected through the cloacal opening and can additionally take place directly through the skin in the body cavity and in the insertions of the extremities. In turtles, injections only can be effected through the cloaca and via the soft skin of the extremities and of the neck, which should be protruded during the fixation process for a proper subsequent identification. While processing the injections, attention must be paid not to inflate the specimens in an unnatural manner. Especially the injections into the autotomizable tail of lizards should be acted with caution, because the tails even can easily break after death. For the study of the outer genitals in squamate reptiles it is furthermore of importance to evert the normally inverted, so called hemipenes before transferring the specimens into the fixation solution. This can be provided by ethanol injection into the ventral tail root. However, by using this method, the organs rarely show a complete eversion, but which is quite important for subsequent systematic studies. Therefore it is recommended to medially unclose the ventral tail root by a longitudinal incision, to excavate both hemipenes, to cut the hemipenial retractor muscle in broad distance to the retracted hemipenis, and to subsequently manually protrude the inverted genital organs (with tweezers), as described in detail in Ziegler & Böhme (1997). Consecutively, the hemipenes can be brought to maximum turgidity by a subsequent ethanol injection. It must be noted, that even while handling dead snakes, the poison fangs can still cause envenomations, because they only become less dangerous after a longer ethanol fixation period. Subsequent to the fixation process in reptiles, which depends from the size and may take hours to days, the specimens are transferred for a long-time preservation into vessels (glasses, plastic jars etc.) containing 70% ethanol. The same as in amphibians, also the natural colour pattern of reptiles is better conserved in already used (and therefore aliphatic) ethanol, than in freshly attenuated ethanol. For the preparation of exhibition specimens see the overviews by Thorns (1988) and Piechocki & Altner (1998).

Collection Management

The collection of animals only makes sense if the collecting and its circumstances are sufficiently documented. To allocate these data to the accordant specimen, an individual labelling is required. The attachment of the numbered field tag usually takes place after the euthanazation and before the fixation process. However, especially when several specimens of the same species are contemporarily collected from different places, it makes sense to already mark the linen bags, for subsequently being able to allocate the specimens to the specific capturing circumstances / microhabitats. An according order or labelling should also be considered while photographing the specimens. One possibility for a proper

allocation of live photographs to certain collection specimens is to photograph the date or the individual field tag, if already available, prior to the photograph of the animal itself.

If subsequent molecular analyses are desired, a tissue sample should be taken after euthanazation and before fixation. Although tissue samples can still be taken from ethanol-fixed and preserved specimens, molecular samples should be removed as soon as possible to prevent contaminations, e.g., with other preservation liquids etc. For taking a tissue sample, at least the tips of the required equipment (scissors, scalpel, tweezers) should be disinfected, e.g., by heating with the flame of a lighter for few seconds. A piece of muscle or liver tissue should be transferred into an uncontaminated vessel (such as Eppendorf tubes), which is filled with preservation liquid such as ethanol for analysis (ethanol absolute). Work hygiene is very important, because even fingerprints can impurify the sample; furthermore, for a proper allocation, it is important to label the molecular sample with the field tag number.

The field tags should be labelled with a pencil or Indian ink, which are not ethanol- and water-soluble; furthermore the labels should be tearproof, ethanol- and waterproof. The field tags are attached with a tearproof twine at the knee bend or around the neck in snakes. During fieldwork normally field numbers are attached, which can consist of the initals of the collector followed by consecutive numbers. These field tag numbers should carefully be recorded together with the collecting circumstances in a field manual or on a laptop.

The most important field notes are the provisional determination of the species, the locality (country, province, district, area, GPS coordinates), the collecting date, the altitude above sea level (a.s.l.), and the collector(s). In addition, any further observation set out in writing may add to a better understanding of the natural history of the species. For example, this can be the time of collecting, climate data (wheather, temperature, humidity), the hardness grade and the pH value of the water (in semi- or aquatic species), a habitat description (vegetation, anthropogenic influence, soil), microhabitat information, activity / behaviour, frequency, syntopic fauna (potential predators, prey taxa) etc.

It must be noted, that certain records are only feasible shortly before or after the capture of a specimen. For example, the weight of the live animal can only be recorded with transportable scales. In snakes, the length (snout vent length, tail length) should be recorded in freshly dead specimens, because distorted or convoluted preserved snakes are difficult and only imprecise to measure. The data which should be recorded prior to the capture are for example the recording of the male advertisement calls in anurans. Sometimes, male frogs even call out of the linen bag or when temporarily housed in the field camp, however, not under the same, authentic conditions than in the habitat. For the subsequent analysis of such bioacoustic data also temperature records from the field are crucial, because the call structure is dependent from the ambient temperature (see also Heyer et al. 1994). Of course, also the call records have to be allocated to the field tag number of the subsequently collected specimen for a proper comparison / identification.

Later, when the field collection is transferred into a scientific museum collection, the series will be inventoried including field numbers and field notes into the museums database (first of all in the inventory register / catalogue, followed by inscriptions into index cards or a computer). While being inventoried in the museum collection, every specimen gets its own museum number, which will be attached in addition to the field tag, preventing the

loss of any information. The museum numbers usually consist of the acronym of the museum together with a consecutive number. The inventory process (labelling, repoting of specimens / glasses etc.) usually takes place in the collections own laboratory. On the basis of the attached museum number, the specimen is at any time related to the museums inventory register and the database, respectively, which contains all corresponding collecting information from the field. Every prepared specimen is principally considered as being part of the museum collection when the inventory process is completed.

Within the museum collection, the inventoried specimen has to be systematically sorted in a cabinet or regal together with conspecific or related taxa. It is practical and space-saving not to put a single specimen into a single vessel but to insert conspecific specimens into a joint vessel. If too many specimens of a single species are available, the individuals of this species should be partitioned into vessels which house specimens from nearby localities or regions. Because the vessels then only would contain specimens with museum tags, it is useful to label the single vessels with an identification plate or tag, which should at least contain the taxon name, the locality / localities, and the museum numbers of the contained specimens. An inlaid-tag should be preferred, because a tag that is merely attached from outside can simply be removed from the vessel and subsequently getting lost. It is also useful to designate the content of a cabinet with panels on their door, including cabinet number, family / families, genus / genera, geographic range and including species.

In the erection of an ethanol collection, the choice of vessels is of great importance, because they must be absolutely closed over a longer period for preventing the vaporescence of ethanol and a subsequent desiccation of specimens. Premises with constant temperatures guard against vaporescence, and evaporation is minimal with ambient temperatures between 8 and 12 °C. A low humidity advances the desiccation of preservation liquid in untight vessels. Otherwise, glasses should also be straightforward to open (thus not being weld-shut or glued), not to interfere subsequent specimen-based scientific studies. To prevent or at least delay bleaching processes of preserved specimens, the collection should at least have light shields (such as sunblinds or black curtains), if the premises should be exposed to the sun. The use of discoloured, brown ethanol is recommended, because the coloration of the specimens will be better and longer preserved than in freshly mixed ethanol blends. During the design of an ethanol collection the protection against fire and the operational safety has to be kept in mind and the legal requirements have to be followed. In specimens or parts of specimens that are not preserved in liquid, eroding by insects (mainly skin beetles and clothes moths) has to be prevented. Pest control measures are the use of insecticides and the contamination of dried specimens, study skins etc. Again, legal regulations have to be followed, because some of the chemicals are harmful to man. The most popular, nontoxic preservative to protect skins from being eroded is borax (natrium biboraticum); for a saturated solution, ca. 30 g borax have to be added per litre water (Thorns 1988).

In the process of developing a scientific collection, especial attention must be paid that sufficient space is available for the increment of growth. The facilities should be expandable even after years and still meet the demands of a secure and clean storage. An ideally constructed depot cabinet should be preferably lightweight, dust-proof lockable and containing adjustable shelves. Especially adapted are such cabinets made by rust-proof steel sheet. The cabinet doors should be opened to the left and to the right. Wooden cabinets are also useful, however, considerably temperature-sensitive in comparison with a

metal cabinet. In lack of space, roll-fronted cabinets are the optimum alternative. Besides the collection cabinets or rooms there must be further premises, e.g., for a laboratory, an office, employment opportunities for guest researchers, and a separately lockable accommodation for loaned specimens. It is a common practice for the transport to ship specimens that were enwrapped in ethanol-moistened clothes and subsequently shrink-wrapped in tight plastic foil. While planning a herpetological museum collection, it is further most important to reserve a special, separately lockable accommodation for the type specimen collection. Additionally, type specimens usually are separately designated by a red tag. A competent and safe storage of these type specimens as irreplaceable documents of the registered biodiversity should be the priority task of a natural history museums research collections. A comparative study of type specimens for the identification of newly discovered species is still indispensable, in particular when these mistakenly already form part of museum collections, and are unmasked as being new by new methodologies (Böhme 2003).

Recapitulatory, for the storing of valuable voucher material obtained during field surveys, a well organized museum and also an infrastructure (including not only scientists but also sufficient technical staff) is required to properly house new collections in conditions that will guarantee the safety of specimens for a minimum of 100 years. Since the summit of Rio in 1992, the meaning of biodiversity research has significantly increased again, which stresses the necessity of ideally and financially well-equipped research collections in large natural history museums within a national and international network. New methods require new kinds of special collections, such as voice archives, tissue collections etc., but extremely important is also the respective education of competent animal taxonomists (Stuebing 1998, Böhme 2003).

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Figure captions

Fig. 1: Field collection of Vietnamese amphibian and reptilian specimens with field tags during ethanol-fixation.

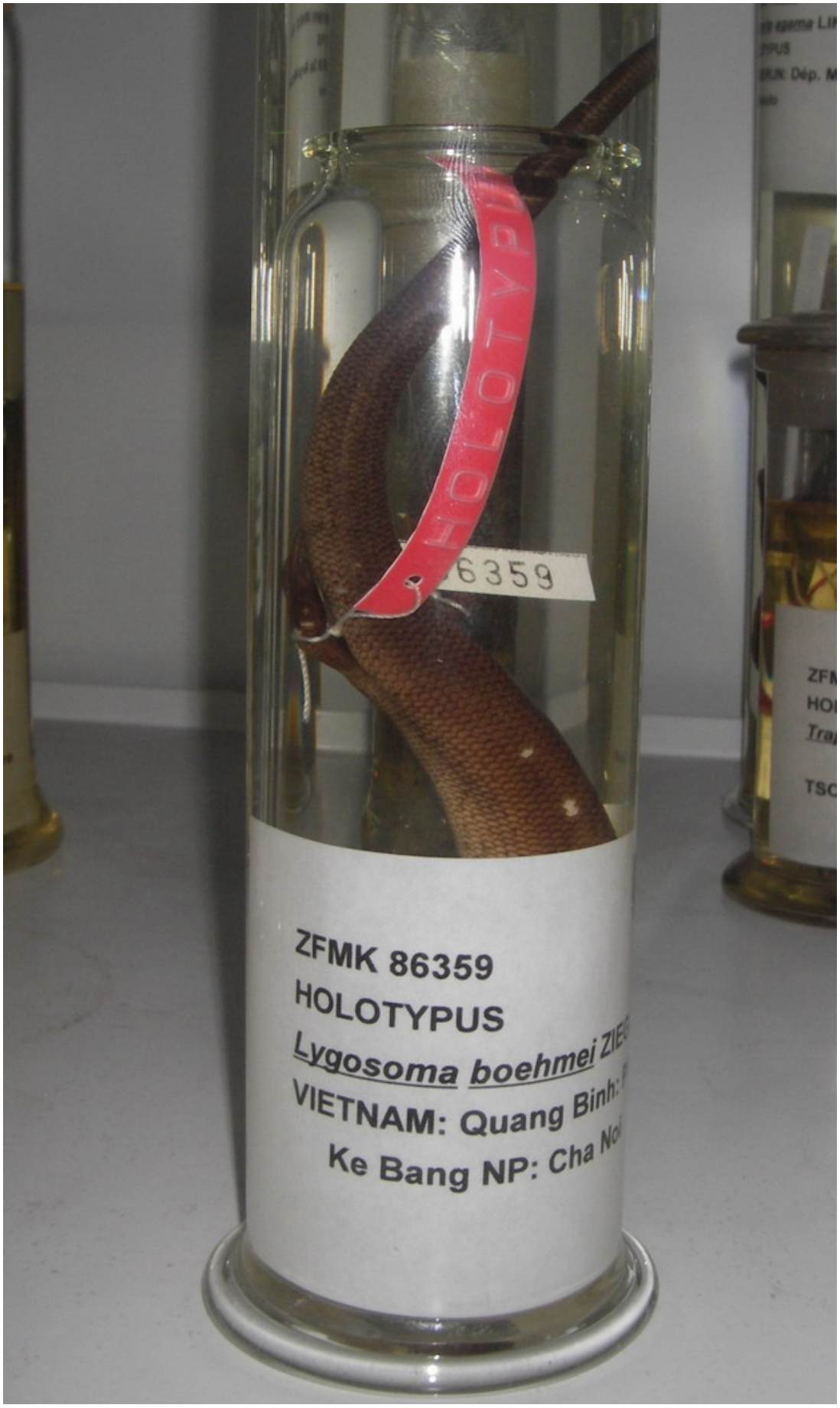
Fig. 2: A local herpetofauna collection with field tags ordered by species groups before inventory.

Fig. 3: Specimens during the inventory process in the laboratory of the herpetological section of the Museum Koenig, Germany: The individual museum collection numbers are attached as memos to a glass containing the corresponding specimen; after the original museum collection tag has been attached, the specimen can be sorted in the museum collection.

Fig. 4: Detail of the snake collection of the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany.

Fig. 5: Snake type cabinet in the herpetological collection of the Museum Koenig, Germany.

Fig. 6: The holotype of *Lygosoma boehmei* Ziegler, Schmitz, Heidrich, Vu & Nguyen, 2007, from the herpetological collection of the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany; note the red holotype label besides the numbered museum collection tag.


HOLOTYPE
6359
ZFMK 86359
HOLOTYPUS
Lygosoma boehmei
VIETNAM: Quang Binh:
Ke Bang NP: Cha