CHAPTER 20

Human Impact on Amphibian Decline in Indonesia

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Abbreviations used in text and references: BP=British Petroleum; CIFOR= Center for International Forestry Research; CI=Conservation International; EPS=Environmental Protection Service; FBRT=Field Biology, Research and Training; FFI=Fauna and Flora International; GLOW=The Great Lakes of the World; INCO=International Nickel Company; IUCN=International Union for the Conservation of Nature; LIPI=Lembaga Ilmu Pengetahuan Indonesia Indonesian Institute of Sciences); NGO=Non-governmental Organization; ODA-ITFMP=Overseas Development Administration-Indonesia-United Kingdom Tropical Forest Management Programme (Program Pengelolaan Hutan Tropis Indonesia-United Kingdom); ITTO=International Tropical Timber Organization; TNC=The Nature Conservancy; WCS=Wildlife Conservation Society; WWF=World Wildlife Fund

I. INTRODUCTION

In the 1950s, a region in the southeastern part of West Java, a swampy area known as Rawa Lakbok (*rawa*=swamp) was famous as the main source of freshwater fishes and once supplied most of West Javan cities. This swamp is now essentially nonexistent and can only be located in old literatures or on old maps. The same is true for Duri, once a swampy area south of Jakarta and from which about ten freshwater turtles were recorded (de Rooij 1917), but now essentially covered with houses. The only remnant of this area still remaining is Jalan bukit Duri in Jatinegara. Situ Aksan (*situ* = lake), from Bandung, West Java, is another example that is now a complex of houses. The same fate soon awaits a very small lake, Situ Ciburuy (Lake of Tadpoles), at Padalarang, Bandung. Numerous examples could be gathered from all over the country (Table 1). Those wetlands are now gone and replaced by gardens and houses. Only the name of a street or a village serves as a reminder that historically there were wetlands around cities; the inhabitants have only a vague idea how the area was decades ago.

Prehistoric Lake Bandung leaves no remnant of its former existence. The city of Bandung is situated at the bottom of highlands, encircled by a dozen mountains and volcanoes, and was once famous for its cool, fresh weather; now in the morning it is just another foggy city like other cities in the lowlands. Forests that once covered most of the surrounding hillsides disappeared, followed by the wetlands. The story of Lake Bandung is a good example of how, for generations, humans have degraded terrain through deforestation and destruction of wetlands and as a consequence. There is a progression of stages through which anthropocentric degradation of habitat occurs. Clearing of forests leads to erosion of topsoil during heavy rains. Nutrients

from the soil washes into bodies of water and causes eutrophication and silting; in this way, lakes become wetlands or can be converted into ricefields. Wetlands abound in insects, amphibians, and birds, as well as in fish that provide subsistence for humans and thus harbour biodiversity, but in turn wetlands are destroyed to provide for construction of edifices.

Loss of wet habitats can lead to decreased diversity of amphibians, or to restriction of their geographic or elevational distributions. For example, early in the 1970s *Microhyla achatina* and *Rhacophorus reinwardtii* inhabited the site of Lake Bandung but nowadays even freshwater has become scarce there. A study of the amphibians of Java concluded that a number of frog species (*Leptobrachium hasseltii, Limnonectes microdiscus, L. kuhlii, Microhyla palmipes*) were originally mainly highland specialists, as almost all museum records were from upland provenances. This is no longer true because those species are now known only from a lowland forest in Java: Ujung Kulon. Were it not for that forest those species would be lost. The surface of tropical rainforest is declining at an alarming rate (Mittermeier *et al*. 1999). The lost of tropical rainforest and especially forest fragmentation create an unbearable climatic condition especially for a number of tropical amphibians and numerous species suddenly disappeared from the global surface. In addition, harvesting of a certain species just for not clearly justifiable reasons, such as exportation for consumption and pet trade happened all over the world. The tropical countries where global warming is not an evident cause to amphibian decline, unfortunately supply their diversity to temperate and rich countries, principally to Northern Asia, Northern America and Europe.

It is evident that amphibians suffer a great deal from global warming (Flannery 2005). Global warming is believed to have resulted from cumulative human activities over more than four centuries. The use of fossil fuels such as coal and oil has been accelerating since the industrial revolution and the invention of machines requiring fuels. The accumulation of carbon dioxide in the atmosphere is one of the causes of the greenhouse effect that leads to global warming and to alternations to climate generally. Another atmospheric disturbance in the ozone-hole.
Although human activities cannot be stopped entirely, intelligent planning can facilitate conservation. The conservation activities in Indonesia directed toward other taxa indirectly have been beneficial for amphibians. Amphibians are small and not so charismatic as more conspicuous taxa, so only a few species are globally protected compared to large mammals or showy birds. Some species of amphibians are listed as endangered, but not a single protected area in Southeast Asia was set aside because of an amphibian species. Most National Parks or conservation areas were established to protect birds or large mammals such as tigers, elephants, rhinoceros, dolphins, whales, and monkeys.

This chapter presents a short review of the conservation activities that directly or indirectly affect the amphibian fauna.

II. THREATS TO AMPHIBIANS

A. Destruction and Degradation of Habitat

Destruction of habitat is a major factor in loss of biodiversity of amphibians and in their decline. Such loss is occurring throughout Indonesia, as implied by the IUCN list for that country. Most destruction of habitat is caused by humans through a variety of agencies; these are discussed in turn.

1. Agriculture

In Indonesia ricefields cover several million hectares and are continuing to expand. This is not sufficient to sustain the human population, as Indonesia is one of the largest importers of rice (and also of wheat, soybeans, and other agricultural products). In Indonesia ricefields are the source of most of the mud, fertilizer and insecticides found in large rivers. These pollutants reduce productivity of the freshwater fisheries and have decimated most of the amphibian fauna. Only a few frog species (*Fejervarya cancrivora, F. iskandari, F. limnocharis, Hylarana chalconota, H. erythraea and Occidozyga lima*) tolerate fertilizers and insecticides (Kusrini 2005).
Shifting cultivation is the clearing, usually by burning, of patches of forest for the raising of crops. As the land becomes depleted, a new patch is selected and the old one allowed to regenerate. Burning of these patches of forest causes immediate damage to the habitat and decreases local biodiversity, produces haze over a large area of the globe, and causes local changes in climate (Iskandar *et al.* 1999; Stuebing *et al.* 1999; Iskandar and Erdelen 2006).

2. Logging

Logging has always been a main agent of degradation and loss of forest habitats and in Indonesia thousands of hectare of tropical forest has been destroyed. Legal logging for timber can be beneficial as long as sound practices are employed and biodiversity is conserved. The aftermath, however, can be disastrous. Once legal logging in an area has been completed, that area is considered by local people as "no-man's-land" and illegal logging operations are initiated.

Illegal logging is usually disguised as legal. Local people have legal access to any kind of forest, including conservation areas, for their own subsistence. However, their standard of living can be raised higher by trading in wildlife, rather than by using it as subsistence food, particularly if there is a lucrative foreign market. The practice of giving concessions from their subsistence entitlements to non-native, wealthy people is one of the strongest motivations for local people to exploit the forest.

3. Mining

It is well known that inland mining has a devastating effect on the environment. The soil become sterile from lack of organic nutrients, and pollution, tailings and other aspects have detrimental effects. The effects of acid rain and water pollution caused by nickel mining in the Soroako region, Sulawesi, for example, is well studied (Chan *et al.* 1984; Robinson 1986; Edinger and Best 2001; Hafner *et al.* 2001). Many proposals about how to handle or reduce the effect of mining have been proposed (Lautenbach 1987; Peters 1995; Gunn and Mills 1998; Keller *et al.* 1999; Labrose *et al.* 2000; Blowes *et al.* 2003) but still mining areas all over the world are

still wastelands. Work by the present authors in a small stream about 20 km from the Soroako mine shows that although the water is flowing and clear, the stream is sterile of amphibians. As data before mining are lacking, effect of mining, although highly likely, cannot be proved.

Local quarries for mining stone, sand and gravel for buildings and housing are prevalent in many places. In some areas where stone is not readily available, corals are used. In addition, minerals are also mined for many other purposes. As long as local mining was carried out by traditional means, its impact was evident only years later, in the form of landslides and other small-scale accidents. Illegal mining for coal, gold, and diamonds and other precious stones is pronounced at all the large Indonesian islands from Sumatra to Papua. Mines that were abandoned because they were no longer economically viable at an industrial scale, were then exploited by local people. The products are often of low quality. Local mining, especially for gold, creates pollution as seen at the type locality of *Barbourula kalimantanensis* (Bickford *et al.* 2008).

4. Tree Plantations

Forests are converted to plantations for the growing of rubber trees, pines and oilpalms, among others. Such conversions take place in most of the wetlands of Sumatra and Borneo. Over the past decade, the area devoted to oilpalm plantations in Indonesia surpassed that of Malaysian oilpalm plantations during the same period, and is now beginning to encroach on lowland forest in Sulawesi and Papua. It is not yet widely known by the public that oilpalm plantations, like shrimp ponds, are only economical for three generations and that this is one of the reasons Malaysia now prohibits further conversion of land for this purpose. Indonesian planters might ignore this fact, however, as it is 10-15 years before a new generation of oil palms should be planted. Unfortunately oilpalm plantations are established in wetlands and these constitute one of the most important carbon sources in the world.

Wetlands are extremely rich in biodiversity of amphibians. Unfortunately surveys were seldom carried out prior to establishment of oilpalms and nothing can be said about changes in amphibian populations during conversion from wetlands to plantations.

Plantations of pines and other conifers are also detrimental to amphibian biodiversity, because the soil became acidic and few plant species will grow in such areas; biodiversity in general, not only of amphibians, drops. *Acacia* plantations are another problem in Indonesia because this plant, aside from growing very fast, also exudates a substance that inhibits the growth of other species (alellopathy).

5. Fisheries

Mangroves suffer mainly from the aquaculture of milkfish (*Chanos chanos*) and shrimp (*Penaeus, Metapenaeus*, and other genera). Unfortunately, a shrimp pond can only be harvested economically for three consecutive years and then abandoned. Local fishermen have no clear idea about the role of mangroves as feeding grounds and breeding sites for fish, as shelter for juvenile fish, shrimps, and crabs, as well as habitat for other wildlife such as birds and monkeys. The functions of mangroves in

supplying carbon and oxygen to the air and in protecting seacoasts from abrasion are almost forgotten.

Freshwater fisheries are also suffering from land conversion. Numerous lakes and wetlands all over Indonesia are converted to other functions. Although most of these wetlands areas were not explored for amphibian species before conversion, clearly a number of a population have become extinct. The only known Javan locality for *Hylarana baramica* near Jakarta was lost because of land conversion.

6. Human Habitation

A considerable amount of forested area has been converted to human habitation. In addition, there is encroachment upon most forested areas for collection of firewood, timber, and other products. Highways and footpaths permit human penetration into forests. Construction of such access ways is extensive, but difficult to quantify.

B. Environmental Contaminants

1. Silting and Pesticides

These three aspects are usually coupled when considering the environmental aspects of growing rice but previously were never exposed as the prime source of contaminants of rivers. Other kinds of agriculture and tree plantation also contribute contaminants to aquatic ecosystems but in much lower quantities. The reason for this is probably political rather than scientific, as the rice industry involves millions of hectares and millions of farmers. Only a revolution in the practice of rice culture is likely to solve this problem. As long as rice remains a primary staple food, aquatic communities, including amphibian assemblages, will suffer and availability of clean freshwater will remain a problem, especially in Java.

2. Household Waste

In cities with more than three million inhabitants, all problems are exacerbated, including crime, availability of clean water, homelessness, poverty, prostitution, traffic, and disposal of household waste. Dumping of waste is despised by everybody, even those who work in waste disposal for their income. Leached materials enter the soil and contain high levels of unwelcome bacteria, toxins, and heavy metals. Such contaminants issuing from household wastes can be self-purified by nature, but when the amounts entering aquatic systems are too high, this is no longer possible and biodiversity in the rivers is reduced. Although about 95% of household wastes are recyclable, the initial mixing of wastes make the process costly. In Indonesia, household structure and the lack of environmental awareness constitute major problems in preventing contamination of bodies of water and in maintaining the biodiversity of aquatic life, including amphibians.

3. Heavy Metals

The heavy-metal contaminants originate primarily from mining. In several mining areas that have been studied, amphibians are virtually lacking. More detailed

study is needed, however, as baseline data virtually do not exist. In Borneo, Sulawesi and any area where illegal mining occurs, especially of gold, contamination by mercury is a problem, not only locally but also regionally. Mercury not only pollutes rivers, the sea, and coastal areas, it can enter the atmosphere and contribute to acid rain. [Blaustein et al., 2003]

4. Acid Rain

Although acid is a major pollutant from mining activities, use of pesticides and emissions from motor vehicles also make an important contribution to the occurrence of acid rain. There is no study from Indonesia about the impact of acid rain on amphibian assemblages. The direct and indirect affects on amphibians need to be defined and the relative susceptibilities of different species need to be assessed.

5. Tailings

Mining companies dump their wastes in mounds called tailings. The material in tailings is not always poisonous, but can cover the stones in streams, kill algae that grows on stone surfaces and clog the gills of tadpoles. In some species tadpoles rely on the algae that grow on stones, but when the stones are covered by silt and tailings, tadpoles are practically exterminated within a very short period.

C. Climatic Change

Although the precise impact of climatic change cannot always be detected because of lack of baseline data, three kinds of effects are evident: seasonal, global warming, and drying.

Seasonal: Alternation of the seasons has been irregular for the past few decades in Indonesia but is difficult to document because of natural year-to-year variation.

Global Warming: In some mountains, the elevational distribution of some species has shifted upward to higher elevations, presumably in response to global warming, but the impact of amphibians has not been studied yet.

Dryness: An effect of global warming has been to reduce the amount of wet habitat. As water recedes in swamps, drier islets expand and connect to each other, thereby not only reducing the extent of favourable habitat for amphibians but posing barriers to their movements. Bickford (1998) reported an effect of El Nino on Papuan Frogs and the same may be true for Indonesian species.

D. Fire

Forest fires can have an effect on biodiversity by directly killing of wildlife. It is worsened by the presence of coal or crude oil deposits in Borneo and Sumatra. In southern part of Papua, bush-fires exterminated many kangaroos, deer and freshwater turtles, but the status of frogs in that area was not reported because they were not considered of importance.
Fire can also have an indirect impact on small species with short life cycles, including amphibians, as reported for the Betung Kerihun National Park in West Kalimantan

(Iskandar *et al*. 1999) and it might affect larger species as well (Gurmaya *et al*. 1999; Rahardjaningtrah and Prayogo 1999).

E. Harvesting

Only few species are harvested. Local people and traders initially attempt to harvest all species, either for food or trade. They became more specific in their choice, however, as many of the species have little value or are difficult to maintain, even for a relatively short period.

1. Skin Trade

Only few species enter the local skin trade and none is designated for export. Only skins of *Limnonectes* and *Duttaphrynus melanostictus* have been observed in local tanneries. At present the volume is low and in some instances the skins are merely the waste from the food trade.

2. Food

At present, the food trade mainly involves species of the family Dicroglossidae, especially the genera *Limnonectes* and *Fejervarya* (Kusrini 2005)**.** In Payakumbuh, West Sumatra, *Limnonectes blythii*, once the West Sumatran "primadona", has now essentially been decimated by export for frogs' legs. Although these species are still exported from West Sumatra, the source is populations harvested from neighbouring provinces such as Riau, Jambi and South Sumatra. In Borneo the food trade is not extensive, but apparently froglegs are sent from Sulawesi to big exporting cities such as Makassar or Jakarta before leaving the country.

3. Pet Trade

So far the pet trade has involved most of the common species of the genera *Litoria, Rhacophorus and Polypedates,* and to a lesser extent *Megophrys, Leptobrachium* and others. The reason for this is because most treefrogs are showy, not very agile, and easy to catch. Up to the present none has been bred in captivity, although some breeder claim to have breeding facilities.

4. Medicine

A large number of skins of reptiles and amphibians enters the medicinal trade in southeastern Asia, expecially Cambodia, Vietnam and China. Local traders in Central and Eastern Java have been observed to target *Duttaphrynus melanostictus*. As this is a common species that is not protected, there is no prohibition against this practice.

F. Infectious Diseases

Chytrid fungi and *Saprolegnia* have not been observed to be responsible for amphibian decline in Indonesia, although both pathogens have been reported from the wild (Kusrini *et al*. 2008b).

III. IMPEDIMENTS TO CONSERVATION

A. Taxonomic Barriers

Amphibians are not as charismatic as are birds and mammals. No area in Indonesia was protected because of an amphibian species. In addition, small species are prone to be neglected and do not appear on priority lists but rather are used to enhance the bargaining position for a protected area defined on the basis of other taxa. For this reason, priorities were set to gather at least a list of amphibian species of a given protected area.

B. Undescribed Species

Over 30 species of the amphibians of Sulawesi are undescribed. In a recent work at Central Kalimantan, four species were new to science [Iskandar and Tjan, 1996; Setiadi et al., 2011; Iskandar et al., 2011]. The present author's work in West Sumatra shows that at least five forms are undescribed. Similar situations are found in many areas throughout Indonesia but Papua seems to harbour the highest number of undescribed amphibians (Richards et al., 2002a, b). In addition, numerous widespread species have been found to consist of a complex of hidden species (Emerson *et al.* 2000; Evans *et al.* 2003; Stuart *et al.* 2006) and these need to be added to the new species recognized on morphological grounds. All these new species should be described as soon as possible.

C. Lack of Basic Biological Knowledge and Baseline Data

Robust ecological data are virtually absent (Table 1). Acquiring permits for research is painstaking and, in many instances, collecting is virtually impossible as law and regulations were based data from mammals and birds. Even experts have difficulties in identifying some small frogs. To determine the identity of some amphibian species, dissection and examination of the skull or scapular girdle under a microscope is essential. Many hidden species can only be identified by molecular analysis or other subtle characters. In the past few decades, a high number of hidden species were revealed in Southeast Asia. As a result, about 90% of Indonesian protected areas lack adequate data, especially for small species such as amphibians. For this reason, assembling data from conservation areas should became a prime priority.

D. Inadequate Capacity-Building and Networking

This impediment can be divided into three different categories:

1. Need for Taxonomists and Ecologists

Taxonomists and Ecologists are an immediate need. There should be a scientist working with amphibians in each province in Indonesia. In order to assemble information on amphibian diversity for actual, and potential, conservation areas in every province.

2. Lack of Handbooks Illustrated in Colour

There is an immediate need for cheap handbooks with coloured illustrations. It is obvious that awareness can only be reached if literature facilitating identification of species can be obtained easily. Piracy of books is not an issue; persons working with wildlife will prefer to have an original book with high-qauality coloured pictures, instead of an illegal copy with only black-and-white photocopies of pictures. Judging from the high biodiversity in Indonesia, there should be a guidebook for each of the major islands, and preferably for each province.

3. Need for Education and Training of Provincial Experts

Only a few educational activities are sponsored by international organizations (e.g., BP, Rufford, Whitley) and local NGOs. At present such educational programs are directed mainly toward local authorities and elementary students. In addition, students from local universities participate in fieldwork. Training of personnel for each province would be an effective way of promoting awareness and the building of capacity and producing experts on the Indonesian fauna is obviously a priority. Educational programs would be more effective if aided by illustrated guidebooks (see above).

E. Need for More Complete Knowledge of Amphibians in Conservation Areas

Closing the gaps in data on amphibians for National Parks and other conservation areas is of top priority and needs to be carried out before undisturbed habitats are gone. A number of groups, such as universities and their students, research institutes, and NGOs have worked independently in a considerable number of National Parks and other protected areas but at present have not consolidated either their techniques or their results. Their findings have not been published in appropriate journals and often are not accessible. The quality of these studies is improving and will do so even more as guidebooks become accessible. Recently, the Indonesian Society for Herpetological Study was established to extend knowledge of the amphibians of conservation areas.

F. Need to Create Conservation Areas

Creating conservation areas appeared to be difficult and only with the aid of big International Organization, have they been successfully established in Sumatra and Sulawesi (CI). Some International NGOs have assisted local NGOs and have created various master plans (e.g. CI, WWF, TNC, WCS) or helped manage protected areas (e.g., WWF, TNC, FFI, CI). So far, however, not a single plan has been developed specifically for areas important specifically for amphibians, nor any proposal for setting aside such an area. As long as good forest still exists in various habitats, practically all amphibian species in western and central Indonesia are expected to be protected.

G. Need to Safeguard Headwaters

In Sumatra, Java, and Sulawesi fields of crops have reached near the tops of several mountains (Talakmau, Singgalang, Ungaran, Dieng, Puncak, Tengger, Lompobatang, Tomohon). These plantations always have problems with drought

during the dry season and consequently it would seem that headwaters and mountain tops should be kept free from agriculture. Although regulations already exist, implementation is still a huge problem.

IV. THE ROLE OF CAPTIVE BREEDING

Although not yet applicable to most Indonesian species, the Conservation Breeding Specialist Group and the Amphibian Specialist Group, together with Zoos, are initiating captive-breeding programs for amphibians. These endeavours will begin with such categories as endangered species or species subject to trade and will target tree frogs of the families Rhacophoridae and Pelodryadidae (Hylidae). Zoos are expected to initiate a list of species from their own region with the help of a scientific board; contributions to the list also can be initiated internationally. The main problem lies with endemic species with restricted distributions mainly in mountains where forested areas have been depleted; e.g., *Philautus jacobsoni* from Mt. Ungaran or *Philautus similis* from Mt. Talakmau. Remnant populations should be sought. For such species, even after being captive bred *ex situ*, translocation would be a serious problem because there would be little or no suitable habitat to which they could be re-introduced.

V. STATUS OF RESEARCH

A. Phylogenetic Studies

Practically all studies have been in collaboration with other laboratories around the world. In Sulawesi, the main emphasis is on Systematics, Biogeography and Phylogenetic relationships carried out jointly with several universities, research institutes, and museums (Emerson *et al.*, 2000; Evans *et al.*, 2003; Stuart *et al.*, 2006; Setiadi et al., 2011). Sumatra and Borneo are at present not well studied, although data are beginning to accumulate.

B. Ecological Studies

Ecological work has been concentrated in Sumatra and Borneo. In Sulawesi, research is not restricted to a particular region or site and consequently ecological data are limited. Javan studies deal mainly with baseline data, and ecological studies, although numerous, are usually students' projects and are rarely published (Kusrini *et al*. 2008a). In Borneo, numerous data were obtained, but presented mostly in the form of reports (Stuebing 1994, 2000; Effendy and Bowen 1996; Iskandar *et al*. 2001; Veith *et al.* 2004; Iskandar 2004).

C. Conservation

Most conservation activities are concentrated near National Parks and conservation areas although several Islands such as Papua, Sumatra, Sulawesi and a part of East Borneo have been assessed (in collaboration with CI, TNC and partly with WCS).

The current knowledge of the conservation status (IUCN) of West Indonesian amphibians is based on studies in Sumatra (Aceh, North Sumatra,

West Sumatra, Bengkulu South Sumatra and Lampung) (Table 2). In Borneo (Karimata, West Kalimantan, Central Kalimantan and East Kalimantan) information has been gathered during the past 30 years (Voris, 1977; Iskandar and Erdelen 2006). Data from Sulawesi are quite robust (more than 10,000 specimens have been collected during the past ten years) including those of a very high number of undescribed species.

Most species from Java are listed as vulnerable. The reason for this classification is clear; most of the lowland forests are gone and the remaining ones are suffering from human activities. Many small protected areas in Java only occur on maps; field studies in many of these places revealed conditions so bad that most of the biodiversity has already been eliminated. Efforts have been made to link several conservation areas and some of these have met with success, but in many cases linkages were impossible because: (1) the corridors between conservation areas have no remaining forest and (2) the areas themselves have already been converted to plantations, or even to human habitations.

A number of species occurring in mountainous areas were listed by IUCN. Many vegetable plantations have already reached, or nearly reached, the peaks of the mountains (e. g., Talakmau, Singgalang, Ungaran, Dieng, Puncak, Tengger, Lompobatang), thereby obliterating natural habitats. These plantations suffer from lack of water in the dry season. Even without further analysis, it is evident that practically all the previous biodiversity of the area is gone. Several species are presented as examples:

Barbourula kalimantanensis (Fig. 1): Although the population at the type locality has disappeared, recent study reveals three new populations (Rachmayuningtyas *et al.,* 2011). It is believed that its newly discovered feature of being lungless may make it more vulnerable to extinction (Bickford *et al*. 2008).

Leptolalax hamidi (Fig. 2): This species is now known from West Kalimantan and Central Kalimantan near the border to East Kalimantan. In Central Kalimantan, it is easily found in the field and relatively common compared to the widespread *L. gracilis* from the same area. On the basis of current information, its conservation status should be re-evaluated in the future.

A number of the species listed by IUCN could not be evaluated because the species could not be located or because the number of available specimens were insufficient for evaluation of conservation status. Search of the literature also revealed a paucity of specimens, mainly types. These species should be placed in the DD (Data Deficient) category, and their study prioritized.

D. Gaps in Knowledge

Despite the existence of data from many places throughout Indonesia, two important areas remain neglected: Maluku and Nusa Tenggara. Both areas consist of a number of islands and very little work has been carried out on them. The small ones, especially, are expensive to reach and in the event of accidents or difficulties, transportation from them is difficult to arrange. Although reduced biodiversity is a common phenomenon on small islands, often there are rewarding surprises, such as

undescribed endemics, or unusual phenomena arising from lack of predators or competitors.

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