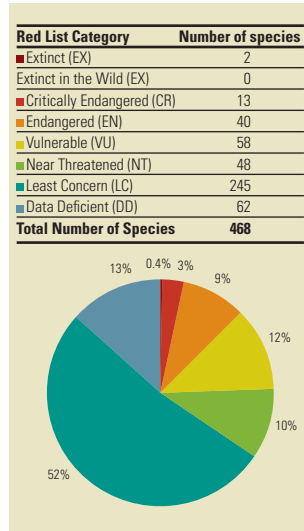




## CHAPTER 10. AMPHIBIANS OF THE PALAEARCTIC REALM

**Figure 1.** Summary of Red List categories for amphibians in the Palaearctic Realm. The percentage of species in each category is also given.



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### THE GEOGRAPHIC AND HUMAN CONTEXT

The Palaearctic Realm includes northern Africa, all of Europe, and much of Asia, excluding the southern extremities of the Arabian Peninsula, the Indian Subcontinent (south of the crest of the Himalaya), Southeast Asia, and the southern parts of China. It is by far the largest of the six biogeographic realms.

The Palaearctic Realm is dominated by the Eurasian tectonic plate, which comprises all of Europe and most of Asia. Over the past 60 million years, the African, Arabian and Indian plates have collided with and compressed the Eurasian plate, forming an extensive array of mountain ranges, generally running in an east-west direction. These ranges include: the Pyrenees; the Alps; the Carpathians; the Balkan mountains; the Caucasus; the mountains of Turkey, Iran, Afghanistan, Pakistan and central Asia; and the Himalaya. The northern part of the African Plate and most of the Arabian plate are now dominated by a Palaearctic fauna, whereas the fauna on the Indian Plate is overwhelmingly Indomalayan (as is the fauna on the south-eastern part of the Eurasian Plate). Although the Palaearctic has an extensive land connection with the Afrotropical Region, there is relatively little mixing of the faunas, due to the barrier to dispersal formed by the Sahara and Arabian Deserts, particularly for organisms such as amphibians. However, there is much more overlap with the Indomalayan fauna, and the boundary between the two regions is hard to delineate in China.

For the reasons given above, the southern part of the region is much more mountainous than the northern part, and includes the highest mountains in the world, peaking at Sagarmatha (Mount Everest) at 8,850m. All of the world's mountains higher than 8,000m occur in the Himalayan and Karakorum ranges.

Boreal coniferous forests dominate the northern part of the region, through Scandinavia and Russia. Further to the south, both the western and eastern parts of the region were originally covered in mixed and broad-leaved temperate forests, giving way to steppe lands in the central part of the region. However, very little remains of the original temperate forest habitat through most of the region. In keeping with the topography, habitat diversity is greater in the southern part of the region, ranging from deserts, to grassland, to Mediterranean-type scrubland, and to coniferous forests.

The Palaearctic Realm has a very uneven human population density (approximately 32 people per square kilometre in Europe in 2005, compared with 137 in China, 339 in Japan, but only 8 in Russia and 11 in Saudi Arabia). The percentage of the population living in rural areas also varies greatly, ranging from 11.5% in Saudi Arabia, to 26.7% in Europe and Russia, 34.3% in Japan, and 59.5% in China. In general, most of the people in the region are concentrated in eastern Asia and western Europe. The gross income per capita also varies hugely across the region, from US\$1,740 in China in 2005, to US\$4,460 in Russia, US\$11,770 in Saudi Arabia, US\$27,900 in western Europe, and US\$38,390 in Japan. Economic growth rates are very high in China (reaching 10% annually), and now averaging 6% in eastern Europe, Russia, and central Asia, but much lower (<3%) in western Europe and Japan.

The high economic growth rate in China, and high overall wealth in Europe, as well as high human population densities, explain why damage to natural ecosystems has been so extensive in the eastern and western parts of the region. In China, but in Europe and the Middle East to an even greater extent, humans modified extensive areas of natural habitat over 1,000 years ago. High levels of habitat modification are still ongoing in China and many other parts of the region. Conversely, in the central and northern parts of the region, many ecosystems are still largely intact.

### GLOBAL CONSERVATION STATUS

A total of 113 species (24%) of amphibian in the Palaearctic Realm is considered to be globally threatened or Extinct (see Figure 1). This is significantly less than the global average of 33%<sup>1</sup>. The

Palaearctic Realm contains 6% of all globally threatened amphibians. The Palaearctic accounts for only 3% of CR species and 5% of the EN species, but 9% of the VU species. Hence, on the basis of current knowledge, threatened Palaearctic amphibians are more likely to be in a lower category of threat, when compared with the global distribution of threatened species amongst categories. The percentage of DD species, 13% (62 species), is also much less than the global average of 23%, which is not surprising given that parts of the region have been well surveyed. Nevertheless, the percentage of DD species is much higher than in the Nearctic.

Two of the world's 34 documented amphibian extinctions have occurred in this region: the Hula Painted Frog *Discoglossus nigriventer* from Israel and the Yunnan Lake Newt *Cynops wolterstorffi* from around Kunming Lake in Yunnan Province, China. In addition, one Critically Endangered species in the Palaearctic Realm is considered possibly extinct, *Scutiger maculatus* from central China. This represents 1% of the 130 possibly extinct species in the world. Clearly, as with the Nearctic, there is little in the way of overall discernible pattern so far in Palaearctic amphibian extinctions.

Despite a lower overall threat to the amphibian fauna in the Palaearctic compared with some other regions, many widespread Least Concern species are seriously threatened in many parts of their ranges. Many countries in Europe, report high levels of threat to their amphibian faunas. For example, Switzerland lists 70% of its species as nationally threatened (Schmidt and Zumbach 2005), even though only one of these species is globally threatened.

### SPECIES RICHNESS AND ENDEMISM

#### Species Richness and Endemism Across Taxa

The 468 native amphibian species in the Palaearctic Realm represent 8% of the currently known global total of 5,915 species. Of these 468 species, 260 (or 56%) are endemic to the Palaearctic (Table 1). Salamanders, newts, frogs and toads are present in the region, but there are no caecilians. Anurans account for over three-quarters (77%) of the species. Endemism is much higher in the salamanders and newts (86%) compared with the frogs and toads (47%). This is presumably a reflection of the generally much smaller range sizes among salamanders, and that the families Salamandridae and Hynobiidae radiated mainly in the Palaearctic (see, for example, Weisrock *et al.* 2006). Of the 15 amphibian families that are native to the region, only three are endemic (Table 1). Only 19 species (4% of the species in the region) are members of these endemic families, although the salamander family Hynobiidae occurs only marginally in the Indomalayan Region and is predominantly Palaearctic.

Under current climatic conditions, there is essentially no isolation between the Palaearctic and Indomalayan Regions, especially in China, and the boundary between these two faunas is somewhat arbitrary. The effect of this indistinct boundary is to reduce the level of endemism of both regions. Summaries of the amphibian fauna of the Palaearctic are provided by Borkin (1999) and Zhao (1999).

There are 66 genera (14% of the global total) occurring in the region, of which 22 (33%) are also endemic. Endemism at the generic level is much higher among the salamanders and newts (72%) than it is among the frogs and toads (10%), a pattern mirrored in the Nearctic. The most speciose genera in the region are *Rana*<sup>2</sup> (83 species), *Bufo*<sup>3</sup> (39 species), *Paa* (24 species), *Hynobius* (24 species), *Xenophrys* (23 species) and *Amolops* (20 species). There are eight monotypic genera endemic to the Palaearctic Realm, all of which are salamanders. The 44 non-endemic genera in the Palaearctic include 37 frog genera (14 genera from the Ranidae, nine from the Megophryidae, seven from the Rhacophoridae, four from the Microhylidae, and one each from the Bombinatoridae, Bufonidae and Hylidae) and seven salamander genera (five from the Salamandridae, and one each from the Cryptobranchidae and the Hynobiidae).

As noted, 15 of the world's 48 amphibian families (31%) occur in the Palaearctic, of which three are endemic: Discoglossidae, Pelobatidae, and Pelodytidae. The characteristics of these families are provided in Chapter 1.

Among the non-endemic families, the majority of Palaearctic species are in the Bufonidae, Megophryidae, Ranidae, Rhacophoridae, Hynobiidae and Salamandridae. Of the Palaearctic Bufonidae, all 39 species are in the widespread genus *Bufo*<sup>3</sup>. This family occurs throughout most of the region, and 20 species (51%) are shared with other regions (mainly Indomalayan, but also Afrotropical). All Palaearctic bufonids breed by larval development, and some of these occur in a wide variety of different habitats.

There are 72 species of Megophryidae in the Palaearctic in nine genera. This family is predominantly Indomalayan, but 30% of the species are endemic to the Palaearctic, occurring mainly in central China. They occur especially in mountainous regions, and the genus *Scutiger* occurs as high as 4,000m in eastern Tibet.

The Ranidae (true frogs) constitute the largest family in the Palaearctic, accounting for just over one-third of the total amphibian fauna of the region. Just over half of the species are in the genus *Rana*<sup>4</sup>. The family is found in almost all parts of the region, occurring in most habitats, and breeds by larval development (except the genus *Ingerana* (four species in the Palaearctic) which are believed to breed by direct development).<sup>5</sup>

The Rhacophoridae (Asian treefrogs) is another predominantly Indomalayan family, with 39 species occurring in the Palaearctic, only six of which are endemic. All the Palaearctic species are in the east of the region (mainly in China). In this region, most of the species breed by larval development, some using foam nests, but a few in the genus *Phyllautus* are probably direct developers.

The Asian salamanders (Hynobiidae) are mainly a Palaearctic family centred on Japan and China, with a few species ranging further west as far as Iran, Afghanistan, ex-Soviet Central Asia and north of European Russia. There are 43 species (87% of the global total for the family) in the region, 40 of which are endemic (and see Essay 10.1).

The Salamandridae are more diverse in the Palaearctic than elsewhere, with 61% of the species occurring in the region. The family also occurs in the northern part of the Indomalayan region, and there are also six species in the Nearctic. They are widespread in the region, but are especially diverse in Europe and China. Most species lay eggs and have free-living aquatic larvae, but 12 species (in the genera *Salamandra* and *Lyciasalamandra*) are live-bearers that do not lay eggs. In some of these species, the young are nourished inside the mother from the embryos of their siblings that die before birth, a unique process in amphibians.

The Palaearctic is also important for three other smaller families. The fire-bellied toads (Bombinatoridae), 60% of which occur in the Palaearctic, are widespread in the region,



*Pachyhynobius shangchengensis* (Vulnerable) is a member of the Asian salamander family Hynobiidae. It is known only from the Dabieshan area in central China, and it lives in slow-flowing hill streams in forested areas, where its larvae also develop. Over-harvesting for human consumption is a major threat to this species. © Arnaud Jamin

**Table 1.** The number of Palaearctic amphibians in each taxonomic family present in the region.

Family	Native species (endemics to region)	Percentage of species in region that are endemic (%)	Percentage of species in family that are endemic to region (%)	Native genera (endemics to region)	Percentage of genera in region that are endemic (%)	Percentage of genera in family that are endemic to region (%)
<b>Anura</b>						
Bombinatoridae	7 (6)	86	60	1 (0)	0	0
Bufo	39 (19)	49	4	1 (0)	0	0
Discoglossidae	12 (12)	100	100	2 (2)	100	100
Hylidae	13 (6)	46	14	1 (0)	0	0
Megophryidae	72 (38)	53	30	9 (0)	0	0
Microhylidae	13 (2)	15	0.5	4 (0)	0	0
Pelobatidae	4 (4)	100	100	1 (1)	100	100
Pelodytidae	3 (3)	100	100	1 (1)	100	100
Ranidae	158 (71)	45	11	14 (0)	0	0
Rhacophoridae	39 (6)	15	2	7 (0)	0	0
<b>TOTAL ANURA</b>	<b>360 (168)</b>	<b>47</b>	<b>3</b>	<b>41 (4)</b>	<b>10</b>	<b>1</b>
<b>Caudata</b>						
Cryptobranchidae	2 (1)	50	33	1 (0)	0	0
Hynobiidae	43 (40)	93	87	7 (6)	86	86
Plethodontidae	8 (8)	100	2	2 (2)	100	7
Proteidae	1 (1)	100	17	1 (1)	100	50
Salamandridae	54 (43)	80	61	14 (9)	64	56
<b>TOTAL CAUDATA</b>	<b>108 (93)</b>	<b>86</b>	<b>17</b>	<b>25 (18)</b>	<b>72</b>	<b>29</b>
<b>TOTAL ALL AMPHIBIANS</b>	<b>468 (260)</b>	<b>56</b>	<b>4</b>	<b>66 (22)</b>	<b>33</b>	<b>5</b>

and also extend into Indomalaya. Two of the three species of Cryptobranchidae (giant salamanders) occur in the Palaearctic, one in China, the other in Japan. These are the largest amphibians in the world, and are associated with clear streams where they breed by larval development. Finally, one of the six species of Proteidae occurs in the Palaearctic (the other five being in the Nearctic). The Palaearctic species is the olm *Proteus anguinus* (VU) which occurs in underground streams in karstic landscapes, in north-eastern Italy, Slovenia, Croatia and a few locations in Bosnia-Herzegovina. It lays eggs, and the adults retain their larval form.

The remaining families include the Hylidae (treefrogs: a large family occurring mainly in the Americas, New Guinea and Australia, with just 13 species in the region, all in the genus *Hyla*), Microhylidae (narrow-mouthed frogs: globally widespread, with just 13 species in the region, none of which are endemic), and the Plethodontidae (lungless salamanders: a large mainly Nearctic and Neotropical family, with just eight species in the region, seven centred on Italy and one in Korea).

The threatened and extinct species in the Palaearctic show very distinct taxonomic patterns (Table 2). Salamanders, which account for less than one-quarter of the species in the region, constitute 45% of the threatened or extinct species, with high levels of threat in all families. Among the larger salamander families, 56% of the Hynobiidae are threatened, and over 40% of the Salamandridae. In both cases, habitat loss and the impact of excessive utilization are the most common threats. This tendency for salamanders to show very high levels of threat is found also in the Indomalayan, Nearctic and the Neotropical Realms. The high level of threat in the Hynobiidae is probably related to the small geographic ranges of many of the species, and their narrow ecological niches in mountainous regions.

Most of the threatened frog species occur in the larger families, Megophryidae and Ranidae (Table 2). The Megophryidae (Asian spadefoots) has a high percentage (one-third) of threatened species, largely due to habitat loss in China, and often very small geographic ranges. These species are usually dependent on clear mountain streams for breeding, a very threatened habitat. The threatened Palaearctic Ranidae (which account for half of the threatened frogs in the region) are overwhelmingly concentrated in China, where they are generally threatened both by over-harvesting for human food, and by habitat loss.

Remarkably, the toads (Bufonidae), which in most other regions show high levels of threat, have no threatened species at all in the Palaearctic. In this region, the family is dominated by widespread, generally adaptable species. There are also low levels of threat in the Rhacophoridae. There are no globally threatened Palaearctic species in the Hylidae and the Microhylidae. Among the small endemic families, threat levels are 25% in the Discoglossidae (painted frogs and midwife toads) and Pelobatidae (European spadefoots), but, at least on the basis of current knowledge, negligible in the Pelodytidae (parsley frogs). It is perhaps noteworthy that 31% of Palaearctic species in the primitive suborder Archaeobatrachia (Bombinatoridae, Discoglossidae, Megophryidae, Pelobatidae and Pelodytidae) are globally threatened, compared with an average of 17% for anurans as a whole in the Palaearctic.

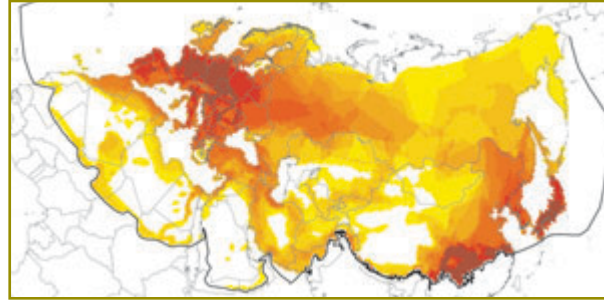
The great majority (87%) of the threatened amphibians in the Palaearctic are in the Endangered and Vulnerable categories. Again, the generally low number of Critically Endangered species masks some important family-level differences, with 12% of the Palaearctic Hynobiidae, and 50% of the Palaearctic Cryptobranchidae falling into this category. Salamanders account for 69% of the Critically Endangered species in the region.

### Geographic Patterns of Species Richness and Endemism

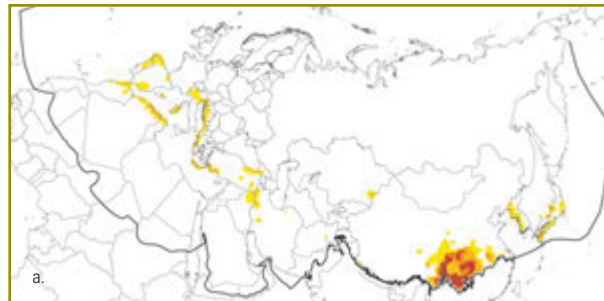
A map of overall species richness of amphibians in the Palaearctic Realm (Figure 2) shows that species richness is low through most of the region, especially in most of Russia and central Asia. In dry areas, such as in much of the Arabian Peninsula and on the Tibetan Plateau, and in very cold areas such as the northernmost belt of the region, there are no amphibians at all. Species richness is highest in China, and moderate in parts of Europe, Japan, and Korea. The high richness in China is partly a reflection of certain species of Indomalayan origin occurring there, as well as the absence of glaciations in much of central and southern China during the Pleistocene ice ages. The Palaearctic Realm is generally well studied, and Figure 2 probably reflects genuine overall patterns of amphibian species richness, though more species are still being discovered regularly, especially in the eastern parts of the region, and sometimes even in western Europe.

Threatened species (Figure 3a) in the Palaearctic are overwhelmingly concentrated in central China (especially in Sichuan and northern Yunnan). Elsewhere, there is little discernible pattern, but with some threatened species in Mediterranean Europe, north-west Africa, Asia Minor, central Asia, and Japan. Not surprisingly, given the small number of species involved, there are no noteworthy concentrations of Critically Endangered species in the region (Figure 3b) (much of the apparent concentration in China reflects the wide distribution of one species, the Chinese Giant Salamander *Andrias davidianus*, which is subject to over-exploitation as a food source).

*The Oriental Fire-bellied Toad Bombina orientalis (Least Concern) is one of ten species in the family Bombinatoridae. It is widespread in the Korean peninsula, north-eastern China, and parts of the Russian Far East. Although generally common, there is concern about the level of harvest for traditional Chinese medicine, and for the international pet trade. © Twan Leenders*



**Figure 2.** The species richness of amphibians in the Palaearctic Realm, with darker colours corresponding to regions of higher richness. Colour scale based on 10 quantile classes; maximum richness equals 40 species.



**Figure 3.** a) The richness of threatened amphibians in the Palaearctic Realm, with darker colours corresponding to regions of higher richness. Colour scale based on five quantile classes; maximum richness equals 11 species. b) The richness of CR amphibians in the Palaearctic Realm. Maximum richness equals one species.

### Species Richness and Endemism within Countries

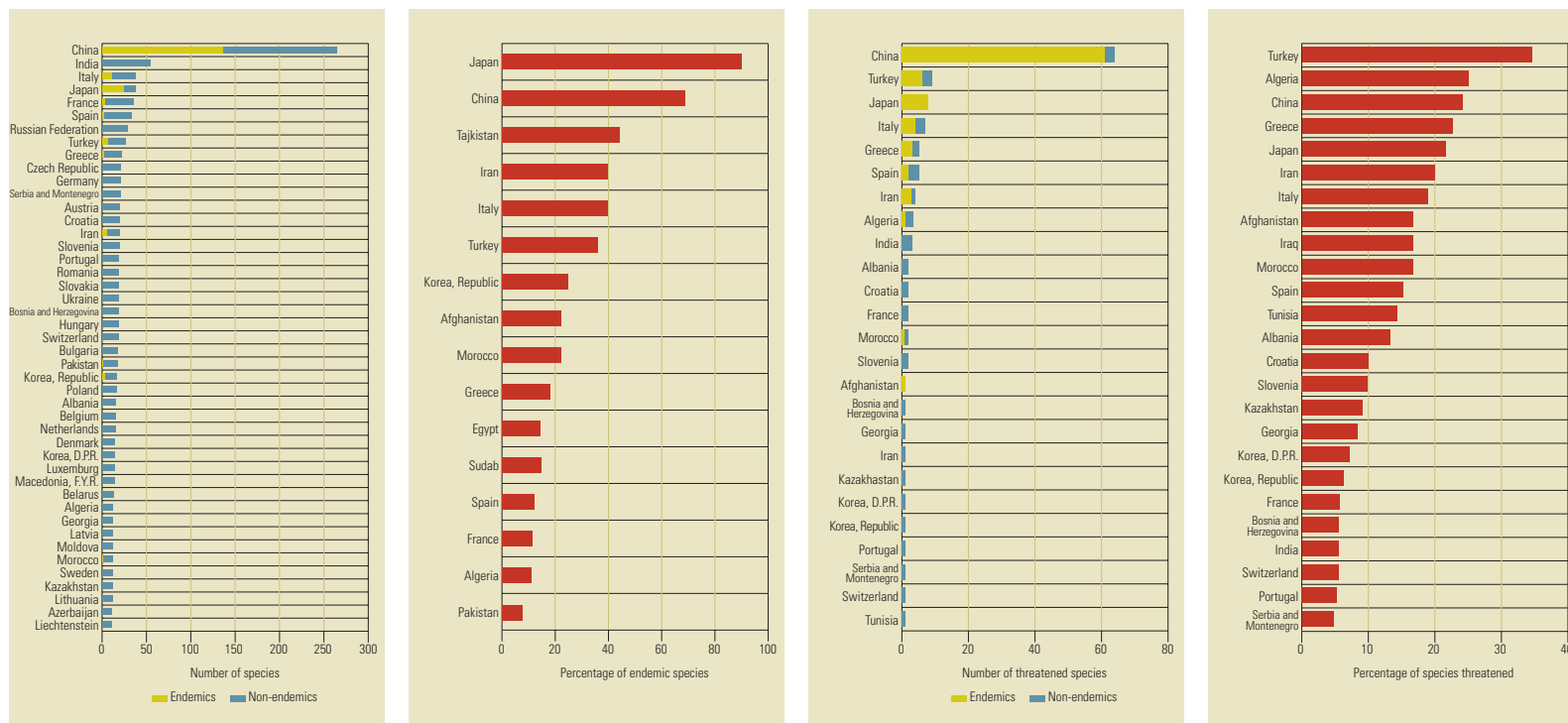
Amphibians are native in 81 countries and territories in the Palaearctic Realm (Figure 4). China has by far the largest number of species and of endemics in the region (265 species, of which 137 are endemic). More than half (57%) of Palaearctic species occur in China, and 29% are endemic to this country (see Essay 10.2). India, although second on the list, extends only marginally into the Palaearctic, and consequently has no endemics in the region. Only four other countries (Japan, Italy, France and Spain) have more than 30 species; remarkably, the Russian Federation, despite its huge size, has only 28 species and no endemics, due to the severe continental climate over a large part of its territory. The low number of species and the low level of endemism in most countries are caused in part by low overall species richness, but also by the small size of many of the countries in the region. After China, only Japan and



*The Alpine Newt Triturus alpestris (Least Concern), in the family Salamandridae, is widely distributed in Europe, occurring in both alpine and lowland habitats including forests, meadows and pastureland. The species breeds, and the larvae develop, in stagnant waters, including shallow ponds, temporary pools, lakes, ditches, drinking troughs, ruts and sometimes slow-moving streams. © Henk Wallays*

**Table 2.** The number of species within each IUCN Red List Category in each Family and Order in the Palaearctic Realm. Introduced species are not included.

Family	EX	CR	EN	VU	NT	LC	DD	Total number of species	Number Threatened or Extinct	% Threatened or Extinct
<b>Anura</b>										
Bombinatoridae	0	0	0	2	0	5	0	7	2	29
Bufonidae	0	0	0	0	3	31	5	39	0	0
Discoglossidae	1	0	0	2	4	5	0	12	3	25
Hylidae	0	0	0	0	0	12	1	13	0	0
Megophryidae	0	2	11	11	5	27	16	72	24	33
Microhylidae	0	0	0	0	0	13	0	13	0	0
Pelobatidae	0	0	1	0	1	2	0	4	1	25
Pelodytidae	0	0	0	0	0	3	0	3	0	0
Ranidae	0	2	11	18	14	89	24	158	31	20
Rhacophoridae	0	0	0	1	5	23	10	39	1	3
<b>TOTAL ANURA</b>	<b>1</b>	<b>4</b>	<b>23</b>	<b>34</b>	<b>32</b>	<b>210</b>	<b>56</b>	<b>360</b>	<b>62</b>	<b>17</b>
<b>Caudata</b>										
Cryptobranchidae	0	1	0	0	1	0	0	2	1	50
Hynobiidae	0	5	8	11	2	11	6	43	24	56
Plethodontidae	0	0	1	2	4	1	0	8	3	38
Proteidae	0	0	0	1	0	0	0	1	1	100
Salamandridae	1	3	8	10	9	23	0	54	22	41
<b>TOTAL CAUDATA</b>	<b>1</b>	<b>9</b>	<b>17</b>	<b>24</b>	<b>16</b>	<b>35</b>	<b>6</b>	<b>108</b>	<b>51</b>	<b>47</b>
<b>TOTAL ALL AMPHIBIANS</b>	<b>2</b>	<b>13</b>	<b>40</b>	<b>58</b>	<b>48</b>	<b>245</b>	<b>62</b>	<b>468</b>	<b>113</b>	<b>24</b>



**Figure 4.** The number of amphibians present in and endemic to each Palearctic country. \*denotes countries not entirely within the Palearctic Realm, hence only the species whose ranges fall within the region are included. Only countries with at least 10 native species are included.

**Figure 5.** Percentage of species endemic to each Palearctic country. \*denotes countries not entirely within the Palearctic Realm, hence only the species whose ranges fall within the region are included. Only countries with at least one endemic species are included.

**Figure 6.** The number of globally threatened amphibians present in and endemic to each Palearctic country. Countries with no globally threatened species are not included in the diagram. \*denotes countries not entirely within the Palearctic Realm, hence only the species whose ranges fall within the region are included.

**Figure 7.** Percentage of native species that are globally threatened. Countries with no globally threatened species are not included in the diagram. \*denotes countries not entirely within the Palearctic Realm, hence only the species whose ranges fall within the region are included.

Italy have more than 10 endemic species (25 and 11, respectively). Thirty-six countries in the region have fewer than 10 native amphibian species (not shown on Figure 4), and only four of these (Afghanistan, Egypt, Sudan and Tajikistan) have endemics (one each).

The amphibian fauna of the Palearctic has been well summarized in extensive review literature. Important regional works include: Ananjeva and Borkin (1981), Arnold (2002, 2003), Balletto *et al.* (1985), Borkin (1984, 1999), Cog Iniceanu *et al.* (2000), Corti *et al.* (1999), Duguet and Melki (2003), Gasc *et al.* (1997), Griffiths (1996), Grossenbacher and Thiesmeier (1999, 2003, 2004), Kuzmin (1996, 1999), Kuzmin and Semenov (2006), Leviton *et al.* (1992), Nöllert and Nöllert (1992), Pleguezuelos (1997), Salvador (1996), Schleich *et al.* (1996), Tarkhishvili and Gokhelasvili (1999), Thorn (1968), Thorn and Raffaelli (2001) and Zhao (1999). There are numerous national-level publications, including, but by no means limited to: Arnold (1995), Baran and Atatür (1998), Bauwens and Claus (1996), Bons and Geniez (1996), Cabela and Tiedemann (1985), Castanet and Guyetant (1989), Crespo and Oliveira (1989), Disi (2002), Fei *et al.* (1999, 2005), García-París (1985), García-París *et al.* (2004), Geniez *et al.* (2005), Goris and Maeda (2004), Groenvelde (1997), Grossenbacher (1988), Khan (2006), Kuzmin *et al.* (1998), Llorente *et al.* 1995, Maeda and Matsui (1999), Malkmus (2004), Moravec (1994), Parent (1979), Pleguezuelos *et al.* (2002), Puky *et al.* (2003), Saleh (1997), Salvador and García-París (2001), Schleich and Kästle (2002), Soccianti (2002), Sindaco *et al.* (2006), Societas Herpetologica Italica (1996), Uchiyama *et al.* (2002), Werner (1988), Ye *et al.* (1993), Zhao and Adler (1993), and Zhao *et al.* (2000).

Although China has many more endemics than any other country in the region, Japan has the highest percentage of endemic species at almost 70% (Figure 5), because of the insular nature of the country. In the Palearctic part of China, over 50% of the amphibians are endemic. In addition to species-poor Tajikistan (already mentioned), high levels of endemism (>20%) also exist in Iran, Italy, and Turkey. In both Japan and China, the levels of endemism are high in frogs and salamanders. In Iran, Italy and Turkey, the endemics are mainly salamanders.

China has many more threatened species (64) than any other country in the Palearctic (Figure 6). Well over half of the threatened species in the region (57%) occur in China, and 50% are endemic to China. Endemic species in China are much more threatened (45%) than non-endemics (2%). The number of globally threatened species is less than 10 in all other countries in the region (Figure 6). The percentage of threatened amphibian species is highest in Turkey (35%), and is greater than 20% in Algeria, China, Greece, Japan, and Iran (Figure 7). With the exception of Turkey, in all Palearctic countries, the level of threat is much lower than the global average of 33%. The high percentage of threatened species in Turkey is a reflection of the presence of nine species of salamanders with small ranges, all threatened by habitat loss.

These figures all relate to the number of globally threatened amphibian species in each country. Many countries, especially in Europe, list many globally Least Concern species as nationally threatened. Assessments of the conservation status of Palearctic amphibians have been carried out in several countries, including, for example: Switzerland (Grossen-

bacher 1994; Schmidt and Zumbach 2005); Japan (Japan Agency of Environment 2000; Ota 2000); Spain (Pleguezuelos *et al.* 2002); and China (Zhao 1998; Xie and Wang, 2004). Corbett (1989) published an overview of amphibian conservation in Europe, while Cox *et al.* (2006) presented a review of the status and distributions in the Mediterranean (and see Essay 10.3). Xie *et al.* (2007) proposed a conservation plan for the amphibians of China.

There are only 13 Critically Endangered Palearctic species, but seven of these occur in China, two each in Iran and Japan, and one each in Afghanistan and Turkey. Outside China, all Critically Endangered species in the Palearctic are salamanders.

## HABITAT AND ECOLOGY

### Habitat Preferences

Most Palearctic amphibians (78%) occur in forests, but almost one-third of the fauna (31%) can survive in secondary terrestrial habitats (Table 3; Figure 8). This latter figure is almost double that of the Nearctic Realm, perhaps suggesting a higher percentage of adaptable species in the Palearctic. As natural habitats have been completely lost in many parts of the Palearctic, some amphibian species are now dependent of artificial habitats. As in other regions, forest-dwelling and stream-associated amphibians are more likely to be threatened than those occurring in any other habitats, with over 20% of these species being globally threatened. This is the combination of habitat preferences that has been associated with rapid declines in amphibian populations worldwide (Stuart *et al.* 2004). Amphibians occurring in savannahs, arid and semi-arid habitats, and secondary terrestrial habitats are less likely to be threatened than those occurring in other habitats (Table 3; Figure 8). At least one highly threatened species, *Ranodon sibiricus* (EN), is mainly associated with forests, but is surviving at much reduced densities in secondary habitats due to the loss of forest cover (Kuzmin and Thiesmeier 2001).

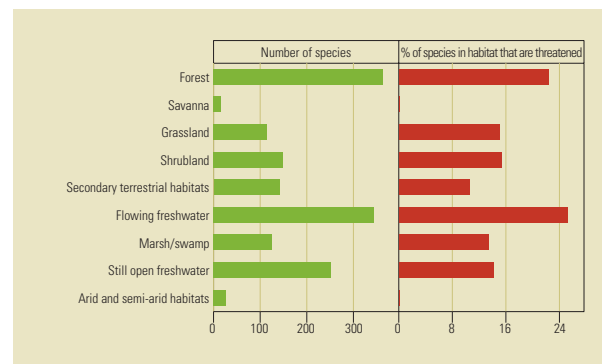
### Reproductive Modes

Larval development is by far the most common reproductive mode in the Palearctic (94% of species), compared with 3% for direct development and 3% live-bearing (Table 4; this compares with the global picture of 68% larval development, 30% direct development, and 1% live-bearing). The Palearctic has a smaller proportion of direct-developing species than in any other region of the world. The direct-developing Palearctic amphibians include plethodontid salamanders in the genera *Speleomantes* and *Karsenia*, and frogs in the genera *Phyllautus* and perhaps *Ingerana*. The live-bearing species are all salamandrid salamanders in the genera *Salamandra* and *Lyciasalamandra*. All of the live-bearing salamanders of the world are found only in the Palearctic Realm.

**Table 3.** The habitat preferences of amphibians in the Palearctic Realm.

**Figure 8.** The habitat preferences of Palearctic amphibians. The plot on the left-hand side shows the number of species in the region in each habitat type. On the right-hand side, the percentage of these species which are threatened is given.

Habitat type	Number of species in each habitat	% of all species occurring in the habitat	Globally Threatened and Extinct species	% of all species in habitat that are globally Threatened or Extinct
Forest	365	78	81	22
Savannah	16	3	0	0
Grassland	114	24	17	15
Shrubland	150	32	23	15
Secondary terrestrial habitats	143	31	15	10
Flowing freshwater	346	74	87	25
Marsh/swamp	127	27	17	13
Still open freshwater	254	54	36	14
Arid and semi-arid habitats	26	6	0	0





The Marsh Frog *Rana ridibunda* (Least Concern) occurs widely from western Europe to western China, with invasive populations spreading in several places in the Palaeartic outside its natural range. It is a highly opportunistic semi-aquatic ranid frog, living in most habitats, especially in open, well-warmed areas with abundant herbaceous vegetation. It may also be found in slightly saline water. © Miroslav Samardži

Reproductive mode	All Species	Threatened or Extinct species	% Threatened or Extinct
Direct development	14	3	21
Larval development	439	101	23
Live-bearing	13	9	69
Not known	2	0	0

Table 4. Palaeartic amphibians categorized by reproductive mode.

Threat type	Threatened species	% Threatened species
All Habitat loss	90	81
Agriculture – Crops	41	37
Agriculture - Tree plantations	4	4
Agriculture – Livestock	16	14
Timber and other vegetation removal	48	43
Urbanization and industrial development	59	53
Invasive species	9	8
Utilization	41	37
Accidental mortality	5	4
Pollution	41	37
Natural Disasters	11	10
Disease	2	2
Human disturbance	11	10
Fire	5	4

Table 5. The major threats to globally threatened amphibians in the Palaeartic Realm. Only present threats to species are tallied.

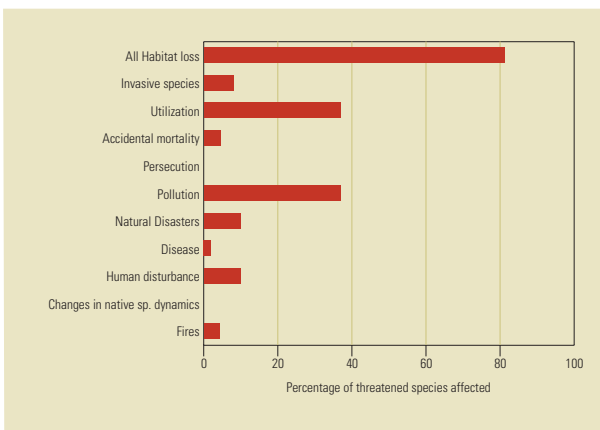


Figure 9. The major threats impacting threatened amphibians in the Palaeartic Realm.

In the Palaeartic, the percentage of globally threatened or Extinct live-bearing amphibians is much higher than in direct-developing and larval-developing species (Table 4), though, in view of the small number of species involved, the significance of this finding is not clear.

### MAJOR THREATS

Habitat loss is overwhelmingly the major threat to amphibians in the Palaeartic (Table 5; Figure 9), affecting over 80% of the threatened species. Pollution and utilization are the next most serious threats, each impacting over one-third of the threatened species. Invasive species, disease, human disturbance and natural disasters also have significant impacts on certain species. Most other threats are of relatively minor importance. Chytridiomycosis has been recorded in many parts of Europe, with records from seven countries and 20 out of 28 species examined (Garner *et al.* 2005, 2006). It has been associated with some serious declines in Spain, but so far only of non-threatened species (Bosch *et al.* 2001). However, it does not seem to kill amphibians in most areas where it has been recorded in Europe, and so its overall impact currently seems to be less severe than in some other regions.

In terms of the types of habitat loss that are impacting amphibians in the Palaeartic, the impacts of urbanization and industrial development (affecting over half of the threatened species), vegetation removal (mainly logging in Asia) (>40%) and expanding croplands and agricultural intensification (over one-third) are the most severe. Tree plantations and livestock are less important threats in most cases. The heavy impact of urbanization and industrialization reflects the high human population density in China, Japan, and Europe in the areas where amphibian species richness is highest. These factors, as well as the extensive development of agriculture, are also important threats in some parts of the former Soviet Union. The coding of major threats used in the Global Amphibian Assessment does not sufficiently depict habitat loss resulting from the over-exploitation of water resources, which is increasingly affecting amphibians in the south-western part of the Palaeartic (especially in the Iberian Peninsula, Greece and northern Africa), resulting in the widespread loss of breeding sites.



The Green Toad *Bufo viridis* (Least Concern) from the family Bufonidae has an extremely wide range in North Africa, Europe, and West and Central Asia. It is one of the most adaptable amphibians of the Palaeartic, living in forests, steppes, dry grasslands, alpine areas, arid habitats (usually close to oases), and urban areas. © Maik Dobiey

The Common Spadefoot *Pelobates fuscus* (Least Concern), one of four species in the family Pelobatidae, ranges from western Europe to central Asia. It occurs mostly in open areas, and burrows in loose soil when not breeding. It breeds in small still water bodies, including ditches, ponds and lakes. © Miroslav Samardžić



**Table 6.** The purposes for which amphibians are used in the Palearctic Realm. The numbers in brackets are the number of species within the total that are threatened species.

Purpose	Subsistence	Sub-national/ National	Regional/ International	Number of species
Food - human	83 (23)	33 (9)	10 (1)	88 (24)
Food - animal	3 (0)	0	0	3 (0)
Medicine - human and veterinary	42 (10)	24 (4)	7 (0)	45 (10)
Pets, display animals	7 (2)	39 (9)	47 (9)	54 (15)
Research	1 (1)	8 (1)	3 (0)	8 (1)
Specimen collecting	1 (1)	7 (7)	8 (8)	9 (9)

**Table 7.** The population trends for all extant Palearctic amphibians.

Population Trend	Number of species	% of extant species
Decreasing	246	53
Stable	126	27
Increasing	5	1
Unknown	89	19

**Table 8.** The number of species in "rapid decline" and "over exploited decline" in the Palearctic Realm by family.

Family	Number of species in "rapid decline"	Percentage of species in family in "rapid decline"	Number of species in "over-exploited decline"	Percentage of species in family in "over-exploited decline"
Bufoinae	1	3	0	0
Discoglossidae	3	25	0	0
Megophryidae	2	3	0	0
Pelobatidae	2	50	0	0
Ranidae	20	13	12	8
Cryptobranchidae	1	50	1	50
Hynobiidae	2	5	1	2
Plethodontidae	1	13	0	0
Salamandridae	10	19	4	7

A total of 153 species (50 of which are threatened) are recorded as being used in the region (Table 6). The most common reasons for harvesting Palearctic amphibians are for food (88 species, mostly at local and national levels), pet trade (54 species, mostly at national and international levels), and medicinal use (45 species, mostly at local and national levels). Not all of the harvesting of amphibians in the region is considered to constitute a major threat to the species. Of the 153 species being harvested, utilization is considered to be a threat for 96 (of which 46 are threatened species for which harvesting is believed to be contributing to a deterioration in their status). Over 60% of these species seriously threatened by over-harvesting occur in China, where many species of amphibians are extensively harvested for human food and medicines. Examples include the Chinese Giant Salamander (which has undergone catastrophic declines), 12 species of ranid frogs (eight in the genus *Paa*), and six species of hynobiid salamanders. Threatened species outside China that are harvested include six species of hynobiid salamanders (in the genus *Hynobius*) in Japan (mainly pet trade), nine species of salamandrid salamanders (in the genera *Lyciasalamandra* and *Neurergus*) in Iran and Turkey (pet trade), and the hynobiid *Ranodon sibiricus* in Kazakhstan (mainly medicinal use). A much higher percentage of Palearctic threatened species is negatively impacted by utilization (37%) than in any other region (Indomalaya is the next highest at 8%). Harvesting of non-threatened amphibians in Russia as food and medicine exports to China (mainly *Rana dybowskii*, but also *R. amurensis*, *R. asiatica*, *R. nigromaculata*, *Bufo gargarizans*, *Hyla japonica* and *Bombina orientalis*) has resulted in significant population declines at regional levels in eastern Russia (Maslova and Lyapustin 2005).

## POPULATION STATUS AND TRENDS

### Estimates of Population Trends

A summary of the inferred population trends of Palearctic amphibians is presented in Table 7. For the majority of the species, these trends are inferred from trends in the state of the habitats on which the species depend (though in some cases, actual population declines have been noted, especially for species that are being over-harvested). The overall trends of Palearctic amphibians reflect a worse situation than the global trend (where 42% are decreasing and only 27% are stable). In both cases, the percentage of increasing species is very small. These results suggest that, although the Palearctic currently has a lower percentage of threatened species than the global average, the situation is probably dete-

riorating, given the high percentage of decreasing species. One reason for the large number of decreasing species is that the majority of the region's amphibians occur in China, where habitat loss and over-harvesting are both serious threats. Many species in Europe are also in decline, especially due to agricultural intensification.

### "Rapidly Declining" Species

Only 42 (9%) of the 470 globally "rapidly declining" species occur within the Palearctic Realm (a full list of all "rapidly declining" species is provided in Appendix IV and includes their occurrence within each of the realms). Eighteen of these species are in decline due to over-exploitation, 23 due to reduced habitat, and one due to so-called "enigmatic declines". Not surprisingly for this region, more declines are attributed to reduced habitat and over-exploitation than to enigmatic declines. The Palearctic accounts for 47% of the world's rapid declines due to over-exploitation, but only 11% of the reduced habitat declines, and 0.4% of the enigmatic declines. One species in the region, *Nanorana pleskei* (NT) from Qinghai, Gansu and Sichuan Provinces in China, has been recorded as undergoing an enigmatic decline, the causes of this decline are not known, and have not so far been linked to either chytridiomycosis or climate change (although these two threats have now been associated with many such declines that have taken place elsewhere in the world (Lips *et al.* 2006; Pounds *et al.* 2006)).

The "rapidly declining" species show a distinct taxonomic pattern (Table 8). Among the larger families, the Ranidae and Salamandridae show a higher tendency to serious decline than the Bufonidae, Megophryidae and Hynobiidae. There are no Palearctic species in rapid decline in the two treefrog families, Hylidae and Rhacophoridae, nor in the Microhylidae. Some small families have high percentages of species in serious decline, most notably the Discoglossidae and Pelobatidae (both families with large tadpoles) and Cryptobranchidae. Among the larger families, "over-exploited declines" are concentrated in the Ranidae and the Salamandridae.

The "rapid declines" in the Palearctic also show a clear geographic pattern. The major concentration of declines is in China (23 species), followed by Iberia (8), north-western Africa (three), and Iran (two). Of the "over-exploited declines", 16 are in China, and two in Iran (*Neurergus newts* in the pet trade). The rapid declines in Iberia and north-western Africa have been linked to loss of habitat due to a long-term drying trend in the climate (see Pleguezuelos *et al.* 2002), linked with the over-exploitation of water resources, which results in the widespread loss of breeding sites.

## KEY FINDINGS

- A total of 468 species are recorded from the Palearctic Realm, of which 113 (24%) are considered globally threatened or Extinct.
- At the species level, 260 amphibians (56% of those present) are endemic to the Palearctic; of the 15 families found in the region, three are endemic, and of 66 amphibian genera occurring, 22 are endemic. Endemism is lower in the Palearctic than some other regions, especially due to the unclear and somewhat arbitrary boundary with the Indomalayan Region, especially in China.
- The percentage of threatened or Extinct species is lower than in many other parts of the world, but highest in the families Proteidae (100%), Hynobiidae (56%), Cryptobranchidae (50%), Salamandridae (41%), Plethodontidae (38%), Megophryidae (33%), Bombinatoridae (29%), Discoglossidae (25%) and Pelobatidae (25%).
- Overall, the threat levels are much higher among salamanders and newts (47%) than frogs and toads (17%).
- Geographic concentrations of threatened species in the Palearctic are overwhelmingly centred on China; elsewhere there is little discernible pattern, though there are small concentrations in Mediterranean Europe, north-west Africa, Asia Minor, Central Asia and Japan.
- China has the largest number of species in the Palearctic Realm (265 species), and also has more endemics (137). Another five countries (India, Japan, Italy, France, and Spain) have more than 30 species, but only two of these (Japan and Italy) have more than 10 endemics.
- China also has by far the largest number of threatened species (64), all other countries having fewer than 10 threatened species. However, the percentage of threatened species is higher in Turkey (35% cf. 24% in China).
- Threatened species tend to show distinct habitat preferences, with forest-dwelling and stream-associated species being the most frequently threatened (22% and 25%, respectively). This mirrors patterns seen elsewhere in the world.
- Habitat loss, primarily due to the impacts of urbanization and industrial development, vegetation removal (mainly logging), expanding croplands and agricultural intensification, is affecting over 80% of the threatened species in the region. Over-harvesting and pollution each impact over one-third of the threatened species. Disease has not been recorded as a significant threat in the region so far, although chytridiomycosis is spreading in Europe.
- The overall trends of Palearctic amphibians are worse than the global situation, with 53% of the species in decline.
- Of the 470 globally "rapidly declining" species, 9% occur within the region. Most of these rapid declines (55%) are caused by severe habitat loss, and 43% are due to over-exploitation. Over-exploitation is a much more serious threat, especially in China, than in any other part of the world.
- Two amphibian extinctions have been recorded from the Palearctic, one in China, the other in Israel. A third species (from China) is possibly extinct.

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The Parsley Frog *Pelodytes punctatus* (Least Concern) occurs mainly in France, Spain and Portugal. It is one of just three species in the family Pelodytidae. It lives in stony and sandy habitats, often in calcareous areas, and can occur in cultivated land. It breeds in shallow, sunny, open waters, including small pools, ditches and slow, small streams. © Jelger Herder

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- 1 P<0.001 (binomial test)
- 2 Frost *et al.* (2006) transfer many of the species to other genera.
- 3 Frost *et al.* (2006) transfer many of these species to other genera.
- 4 Frost *et al.* (2006) transfer many of these species to other genera.
- 5 Under Frost *et al.*'s. (2006) arrangement, the Palearctic species in the genera *Chaparana*, *Euphylyctis*, *Fejervarya*, *Hoplobatrachus*, *Limnonectes*, *Nanorana*, *Occidozyga*, *Paa*, and *Sphaerotheca* are transferred to the predominantly Indomalayan family Dicroglossidae. Most of these species are in China, but others occur further west in western Asian and even north-western Africa. Some other Palearctic "ranids" are transferred to other families under Frost *et al.*'s proposed classification: one species to the Afrotropical family Pyxicephalidae (*Tomopterna cryptotis*); four species in the genus *Ingerana* to the Oceanian and Indomalayan Ceratobatrachidae; and two species in the genus *Ptychadena* to the Afrotropical Ptychadenidae. Even with these changes, the Ranidae have just over 100 species in the Palearctic, and remain easily the largest family in the region.

ESSAY 10.1. CURRENT STATUS OF JAPANESE SMALL SALAMANDERS OF THE GENUS *HYNOBIUS*

The Japanese archipelago includes more than 3,000 islands. In addition to the four main islands — Hokkaido, Honshu, Shikoku and Kyushu — the archipelago includes smaller island groups, such as the Ogasawara-shoto (the Bonin Islands and Iwo or Volcano Islands), and the Nansei-shoto (Ryukyu and Satsunan Islands) (Figure 1).

The amphibian fauna of Japan is represented by 56 species. Endemism is marked, with around 45 species found nowhere else. One-third of the endemic species belong to the genus *Hynobius*, a diverse group of 27 small salamander species in the family Hynobiidae, with its only other representatives in mainland China (six species), the island of Taiwan (three), and the Korean Peninsula (three). Most species in the genus have allopatric distributions (for example, the Hokkaido or Ezo Salamander *H. retardatus* is the only species found on Hokkaido, the most northerly of the Japanese islands) and very small ranges. For example, the Critically Endangered Oki Salamander *Hynobius okiensis* is confined entirely to the island of Dogo in the Oki Islands in Shimane Prefecture, while the Tsushima Salamander *H. tsuensis* (LC) is found only on the island of Tsushima (Figure 1).

Sixteen species of the genus are recorded from Japan, all of which are endemic. As a result of studies involving the use of molecular techniques, three new species have been described since 1984, including *Hynobius katoi* (DD) described only in 2004 from montane regions of the Chubu District in south-central Japan (Matsui *et al.* 2004). More recent studies are also revealing the presence of large genetic variation in wide-ranging species, and the number of species is likely to increase. For example, among the stream-breeding, montane species, the Odaigahara Salamander *H. boulengeri* (VU) has been shown to comprise at least three species, each occurring on different islands of Japan (Nishikawa *et al.* 2001). The Blotched Salamander *Hynobius naevius* (LC) is also known to contain two lineages that are partially syntopic and surely represent different species (Tominaga *et al.* 2003). Similarly, the Hida Salamander *H. kimurae* (LC) is genetically split into two distinct lineages that are morphologically quite different as well (Matsui *et al.* 2000). Likewise, still-water (lentic) breeding, lowland species are known to exhibit a great deal of intraspecific variation. It is certain, for example, that *H. nebulosus* (LC) from western Japan contains more than two species,

although delimiting the geographic boundaries between the two is not easy due to their complex variation patterns (Matsui *et al.* 2006). Finally, Tohoku Salamander *Hynobius lichenatus* (LC) from eastern Japan is also split into several distinct genetic lineages that may warrant recognition at the species level (Aoki and Matsui unpubl.).

Hynobiid salamanders are highly aquatic, occurring in streams and pools, and breed by means of external fertilization, with the eggs laid in two distinctive egg-sacs that are attached to rocks or submerged vegetation. The male remains in the vicinity of the egg sacs, possibly for parental care, in some species. The larvae typically hatch and metamorphose in the same year as the eggs are laid, but in most species (e.g., Abe's Salamander *Hynobius abei*; CR), a few larvae may overwinter and only metamorphose the following year. In fact, in the Odaigahara Salamander, the large overwintering larvae sometimes prey on the next year's batch of new larvae (Nishikawa and Matsui unpubl.).

Currently, around one-third (20 species) of Japan's amphibian species are considered threatened, eight of which are from the genus *Hynobius*. However, the impending taxonomic division of several wide-ranging species discussed above will almost certainly result in an increase in the number of species listed as threatened in the near future. Abe's Salamander, currently categorized as Critically Endangered (which together with the Oki Salamander are the only two Critically Endangered amphibians in Japan), has recently been found from several new localities, although these discoveries were made prior to ongoing land development in the area. Today, *H. abei* is specially protected by the Japan Environment Ministry, and the capture of individuals and the modification of its habitats are strictly regulated.

For many years, the ranges of still-water breeding lowland species have been much impacted by increasing land development, including road construction and changes in cultivation practices. In an attempt to increase rice production, cultivation of rice paddies was halted for a season or seasons, and then bulldozed flat and reconstructed into large rectangles with the original fertile substrate mud bulldozed back into the paddies. The result of such development was large-scale devastation of the amphibian fauna, exacerbated by the fact that bulldozing usually took place in autumn and winter, when populations were hibernating (Matsui 2002). Besides lowland species,

stream-breeding (lotic) montane species are now also subject to increasing habitat degradation as a result of the construction of montane roads and dams, as well as ongoing deforestation at higher elevations. Over-harvesting of animals for the national pet trade is also an important threat for species such as Tokyo Salamander *H. tokyoensis* (VU) and the Oita Salamander *H. dunnii* (EN). As a result of these threats, many local governments are trying to implement legislation to restrict the collection of animals and to prevent land development projects that are detrimental to the salamanders' survival. Habitat restoration and captive-breeding programmes have been attempted for a number of species, but both efforts are currently hampered by an often limited knowledge of species-specific life histories.

Masafumi Matsui

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**Figure 1.** Map of Japan showing the main islands and island chains, and the distribution of the genus *Hynobius* in the Japanese Archipelago.

*Hynobiid salamanders are highly aquatic, and breed by means of external fertilization. Females deposit a pair of distinctive egg sacs (here Hynobius tokyoensis), including a full clutch of unfertilized eggs, and males focus on these egg sacs during breeding, rather than on the female.* © Henk Wallays



## ESSAY 10.2. CONSERVATION NEEDS OF AMPHIBIANS IN CHINA

China is one of the most geographically varied countries in the world. Its landscapes include the highest mountains and plateaus, vast river basins, deserts and wetlands, the most extensive karstic region on earth, and both temperate and tropical forests. China spans the Indomalayan and Palaearctic Realms, and much of the country is considered to be a transition area between them (Zhao 1999). As a result, the country is particularly rich in biodiversity, with many endemic species, especially in the southern and south-western parts of the country that were never affected by glaciations.

There are 346 extant native amphibians in China<sup>1</sup> comprising 299 species of frog, 46 salamanders and one caecilian, plus two extinct species: *Cynops wolterstorffi* (globally Extinct) (He 1998) and *Echinotriton andersoni* (extinct on Taiwan, still present in the Ryukyu Islands, Japan). China's amphibian diversity is greater than in any other country in the Old World, and is the fifth highest in the world. Further, China has the third highest salamander diversity in the world after the USA and Mexico. Diversity is highest in the centre and south of the country, and lowest in the north. Three of the regions with the highest diversity are Hengduan, Wuyi, and Nanling Mountains, where the faunas comprise Indomalayan and Palaearctic elements. Two other regions of high diversity are in the southern tropical regions of Xishuangbanna and Hainan. China is also important in terms of endemic species, with 198 species occurring nowhere else, putting the country in sixth position globally.

According to the results of the Global Amphibian Assessment, 98 amphibian species in China (28% of the total) are Extinct or globally threatened and 66 species (19%) are categorized as Data Deficient, most of which are likely to prove to be highly threatened. Threatened species are concentrated mostly in the central and southern parts of the country, Hainan Island being the place with the highest concentration of threatened species. Unfortunately, the current protected area network in China (Xie 2003) does not provide adequate coverage for Chinese amphibians (Rodrigues *et al.* 2004). Most of

the large nature reserves are in areas with few or no amphibians (especially in the north and west of the country), while many of the most important sites in the central and southern parts of the country are not properly protected. With the exception of the Chinese Giant Salamander *Andrias davidianus* (CR) (and see Essay 4.7), very few nature reserves have been established for amphibians in China and managed appropriately, and those that do exist are usually protected only at the county level.

The eight Critically Endangered species are of very high conservation priority, and occur in scattered locations across central and southern China. Seven of these species (two salamanders: *Echinotriton chinhaiensis* and *Hynobius amjiensis*; and five frogs: *Oreolalax liangbeiensis*, *Rana chevronta*, *R. minima*, *R. wuchuanensis* and *Scutiger maculatus*) have very small distributions, and these can readily be protected in a small number of reserves. Of these, *E. chinhaiensis*, *O. liangbeiensis*, *R. minima* and *R. wuchuanensis* are not present in any nature reserve, and their sites need urgent protection if they are to be saved from extinction. Unlike the other Critically Endangered species, the Chinese Giant Salamander still occurs very widely, but is now extremely rare throughout its range and has disappeared from many areas (Zhang *et al.* 2002; Wang *et al.* 2004). Some other very threatened species that are very high priorities for conservation attention in China, but that also occur in other countries, include *Leptolalax ventripunctatus*, *Rana psaltes* and *Ranodon sibiricus*.

Salamanders (with 59% of species threatened or Extinct) are much more threatened than frogs (24%), and 63% of the salamander species are used in some way by humans. At the family level widely divergent patterns are seen. Over 60% of the threatened species occur in the two largest families, Ranidae and Megophryidae, both of which also have high percentages of threatened species (26% and 34%, respectively). However, several smaller families show a higher propensity to become seriously threatened, especially Bombinatoridae

(60% of species threatened), Cryptobranchidae (100%), Hynobiidae (74%) and Salamandridae (40%).

In China, most conservation is implemented at the provincial level. It is, therefore, important to indicate the relative importance of the different provinces for amphibian conservation. Sichuan has easily the largest number of seriously threatened species, followed by Yunnan, and other provinces in central and southern parts of the country are also important. However, the percentage of threatened species shows a somewhat different pattern, with the Provinces of Qinghai, Sichuan, Ningxia and Taiwan scoring the highest, followed by Hainan, Guizhou, Shaanxi, Shanxi and Henan. Sichuan scores more highly in terms of both numbers and percentages of threatened species, reflecting its high level of endemism, with many severely threatened species with very restricted ranges.

Over 80% of the threatened species are associated with forests, and over 80% occur in or around flowing water, usually streams. Streamside species appear to be particularly at risk, and in China these species are threatened by alien invasive species, pollution, dams, over-harvesting, siltation, and general habitat degradation. Forest species are especially threatened because they tend not to be very adaptable, and timber harvests in China have increased 18-fold in the past 50 years, while the area of natural forest has declined by 30% (Li and Wilcove 2005).

Habitat loss is by far the most pervasive threat, affecting 94% of threatened species, compared with utilization (34%) and pollution (23%). However, when utilization is operational, it often drives species to threatened status more rapidly than is the case with the other threats. A total of 78 species of amphibian in China is negatively impacted by utilization (Table 1), of which 16 are rapidly declining (as defined by Stuart *et al.* 2004), out of a total of 22 rapidly declining species in China. More significantly, utilization is a major factor in 28 out of a total of 34 category deteriorations in China (category deteriorations are



Family	Number of species adversely impacted by utilization	Number of rapidly declining species threatened by utilization	Number of category deteriorations for utilized species
Bombinatoridae	2	0	0
Bufoinae	4	0	0
Hylidae	2	0	0
Megophryidae	8	0	0
Microhylidae	0	0	0
Ranidae	33	12	21
Rhacophoridae	3	0	0
Cryptobranchiidae	1	1	3
Hynobiidae	12	1	2
Salamandridae	13	2	2
Ichthyophiidae	0	0	0
<b>Grand Total</b>	<b>78*</b>	<b>16</b>	<b>28</b>

**Table 1.** The impact of utilization on China's amphibians. Rapidly declining species are those that have deteriorated in Red List category since 1980. One category deterioration is a movement of a species by one Red List category since 1980. For example, a movement of one species from Least Concern to Near Threatened is one category deterioration. A movement of two species from Least Concern to Near Threatened is two category deteriorations. A movement of one species from Near Threatened to Critically Endangered (as is the case with *Andrias davidianus*) is three category deteriorations.

\* If the disputed area with India is included, 84 species in China are adversely impacted by utilization.

defined in the footnote to Table 1). In short, although utilization impacts many fewer species than habitat loss, it is the major threat driving species into rapid decline in China. Rapid species in particular are threatened by over-harvesting for food, most notably the genus *Paa*, which has seven rapidly declining species (accounting for 14 category deteriorations), all as a result of utilization. *Paa* are large, economically valuable frogs, and according to Ye *et al.* (1993), 75% of the species in China are used as human food at the sub-national or national level. The Chinese Giant Salamander is probably the species that has declined most seriously as a result of over-harvesting.

Xie *et al.* (2007) have provided the basic outline of a conservation strategy for China's amphibians. The key elements are: 1) conservation of important sites and habitats for amphibians; 2) managing for sustainable harvests; 3) scientific research (on taxonomy, threatening processes, and basic species biology); 4) planning for chytridiomycosis (not yet recorded from China); and 5) rationalizing governmental responsibility for amphibians (at present, responsibility for frogs falls under the State Forestry Administration, whereas that for salamanders is under the Ministry of Agriculture, thus making a coherent approach to amphibian conservation difficult). It is now a high priority for China to develop and implement a nationwide strategy to save its remarkable amphibian fauna.

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- 1 Since the completion of data collection for the analysis in this book, eleven new amphibian species have been described from China, making a total of 357 species in the country. However, if the disputed area controlled by India is included, then there are 365 species in China, rising to 376 with the new species descriptions. Note that for the purposes of this essay, Taiwan, Province of China, is included, although statistics for this island are presented separately elsewhere in the book.

## ESSAY 10.3. THE STATUS AND DISTRIBUTION OF AMPHIBIANS IN THE MEDITERRANEAN BASIN

The Mediterranean Basin stands at the intersection of two major landmasses, Eurasia and Africa. During the mid-Tertiary, a collision between these two continental plates – the northward moving African-Arabian continent and the stationary Eurasian plate – produced an unusual geographical and topographical diversity, with high mountain ranges (more than 4,500m in elevation), peninsulas, and one of the largest island archipelagos in the world, with almost 5,000 islands and islets. Biogeographically, the Mediterranean Basin is usually taken as that portion of land around the Mediterranean Sea that has a Mediterranean climate, but for the purposes of this essay we take a relatively loose definition of the Mediterranean Basin, combining a geographic focus on states with a pragmatic cut-off point to the north and west in Europe and Turkey, and in the Sahara Desert to the south. Despite this broader definition, the region is still characterized first and foremost by its climate, where mild wet winters alternate with long hot dry summers. In some parts of the Mediterranean (such as the coastal areas of Libya and Egypt), annual rainfall can be as low as 50mm per year, whereas in the wetter regions, such as the Adriatic coast of the Balkan countries, annual rainfall can exceed 1,000mm.

As with other Mediterranean-type landscapes across the world, including for instance the Cape Fynbos region of South Africa and south-western Australia, the defining characteristic of the region, at least in terms of biodiversity, is the richness of plant species. The flora of the Mediterranean Basin is estimated to include around 25,000 species of vascular plants, 13,000 of which are endemic (Médail and Myers 2004). This remarkable floristic diversity, combined with a concomitant high level of threat, has led to the region being designated as a global biodiversity hotspot. However, as with other Mediterranean-climate regions, diversity and endemism among vertebrates are much lower than that for plants, particularly for birds and mammals. The mammal fauna is largely derived from Eurasian and African elements (even the North African mammal fauna has closer affinities with tropical Africa than with the Mediterranean Basin), whereas the avifauna is dominated by Eurasian elements. Diversity among vertebrates is highest among reptiles, with approximately 355 species present in the region, of which 170 are endemic (Cox *et al.* 2006).

Amphibian diversity in the Mediterranean Basin is much lower than reptile diversity, this being largely a reflection of the extent to which arid and semi-arid habitats predominate within the region. However, at 64%, regional endemism among the Mediterranean amphibian species is relatively very high. The family Discoglossidae (painted frogs and midwife toads), is almost endemic to the Mediterranean region, and two of the three species of Pelodytidae (parsley frogs) are fully endemic. All four members of the

Pelobatidae (Eurasian spadefoots) occur in the region, two of them being wholly restricted to the Mediterranean. Among the newts and salamanders, 49% of the world's 70 Salamandridae species occur in the region, with five endemic genera (*Chioglossa*, *Euproctus*, *Lyciasalamandra*, *Pleurodeles* and *Salamandrina*<sup>1</sup>). The region is also noteworthy for its seven endemic cave salamander species of the genus *Speleomantes* (family Plethodontidae). Until the recent discovery of a species in Korea (Min *et al.* 2005), these were thought to be the only Old World members of a family that has around 350 species in the Americas. The single Old World member of the Proteidae, the olm *Proteus anguinus*, is found only in a small part of north-eastern Italy and otherwise Slovenia, Croatia and a few localities in Bosnia-Herzegovina; the other five members of the family occur in eastern North America.

The richness of amphibian species in the Mediterranean basin is highest in Europe (Figure 1), especially in areas of higher rainfall. Diversity is much lower in the eastern and southern parts of the region. Amphibians clearly avoid arid areas, and are absent from most of the arid Sahara. According to the results of the Global Amphibian Assessment, 25.5% of the Mediterranean amphibian species are considered to be threatened, with 1% Critically Endangered, 12% Endangered and 12% Vulnerable. The most notable concentration of threatened species is Sardinia, Italy, with four threatened species present on this island (Figure 2). One species is listed as Extinct, the painted frog from Israel, *Discoglossus nigriventris*. Recent surveys conducted in Lebanon following reports that the species may survive in the Aammij marsh in south-east Lebanon unfortunately failed to find any individuals of this species (Tron 2005).

The human population of the Mediterranean-rim countries currently is around 400 million people, with most people concentrated along the coast. A steady historical and continuing migration towards coastal areas, and specifically in the south and east of the Mediterranean, has resulted in growing pressure on the coastal environment and, more importantly, on its biodiversity. After several millennia of human impact, most of the region's deciduous forests have been converted to agricultural lands, evergreen woodlands, and maquis, many wetlands have been lost through drainage and diversion often to irrigate crops, and increasing aridity combined with unsustainable farming and range management practices have led to continuing desertification and land degradation in many areas. Interestingly, amphibian families that have a higher percentage of threatened species are also those considered to be more primitive phylogenetically, and coincidentally those that have large tadpoles making them more dependent on the temporal availability of water, as well as on the presence of available resources in this water to grow to reach maturity.

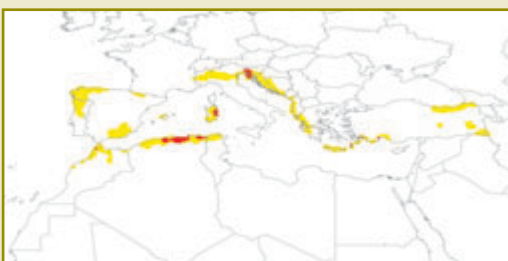
More recently, tourism has had a serious impact on the environment, particularly in western and southern Turkey, and in Cyprus, Tunisia, and Morocco, as well as the Mediterranean islands of the Balearics (Spain), Sardinia and Sicily (Italy), and the Cyclades Archipelago and Crete (Greece). Not surprisingly, then, habitat loss and degradation, mainly due to agriculture and infrastructure development, has had the largest impact on the region's amphibian fauna, currently affecting 19 of the 27 threatened species. However, pollution also has been a major threat, followed by invasive alien species (e.g., *Ficetola et al.* in press) not to mention predation by domestic and commensal mammal species. Finally, there is also the risk that the fungal amphibian disease chytridiomycosis could become a more serious threat to amphibians in the Mediterranean basin in the future. Chytridiomycosis was first recorded in the Mediterranean Basin in Spain in 1997, and has since been implicated in declines of the Mediterranean populations of the common midwife toad *Alytes obstetricans* (Bosch *et al.* 2001) as well as the fire salamander *Salamandra salamandra* and common toad *Bufo bufo* (Bosch and Martínez-Solano 2006). If this fungal disease starts to become as pathogenic to Mediterranean amphibians as it has done to species elsewhere in the world, then it could rapidly become a much more serious threat in the region. In particular, other species of midwife toad (i.e., *Alytes cisternasii*, *A. dickhilleni*, *A. maurus* and *A. mulletensis*) may be susceptible to the disease. If this is the case, species infected with the disease, and especially those with small insular ranges, could quickly move into a higher category of threat.

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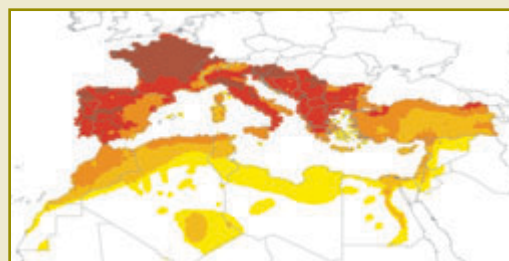
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- 1 At the time of writing, the genus *Calotriton*, represented by two species, had been removed from the synonymy of *Euproctus* (Carranza and Amat 2006).



**Figure 1.** Richness map of all amphibians in the Mediterranean basin, with dark red colours corresponding to regions of higher richness. Colour scale based on 10 quantile classes. Maximum richness equals 18 species.



**Figure 2.** Richness map of all threatened amphibians in the Mediterranean basin, with dark red colours corresponding to regions of higher richness. Colour scale based on five quantile classes. Maximum richness equals 3 species.