Chapter 10
Species

Because of its geographical location, size and geological origins (see Chapter 3), Denmark's flora and fauna appear modest in comparison with those of other parts of the world. Our country and its neighbours are remote from the places that house large numbers of species *(diversity centres)* or that have large numbers of species with an extremely narrow distribution *(endemic species)*.

Most of Denmark's plants and animals have very large areas of distribution. They occur in many of our neighbouring countries, in their adjoining land areas and, in fact, over entire continents.

Despite this, Denmark has a large number of valuable habitats, which help to support populations of species that are threatened over most of their range of distribution, however large.

We also have areas in which certain widespread species stay for a significant part of their life cycles. Thus, at the species level, Denmark has unique natural assets, all of which contribute to the world's total biodiversity. There is, therefore, all reason to protect these assets and conserve them for posterity.

Status of Denmark's plant and animal life

Total number of Danish species

The copious range of Danish reference works on botany and zoology bear witness to an extensive body of knowledge on a very large number of native species. We have a century-old tradition of recording the species that occur in our nature and for publishing descriptive works, some of high scientific standard and accuracy and some of more popular character and content.

Against this background, it is possible to make an estimate of the total number of species in Denmark. About 30,000 native, introduced or adventive species of plants and animals have been recorded - not counting bacteria, single-celled algae and certain lower groups of animal. All of these species occur in this country in populations that are capable of reproducing; see Fig. 10.1. The uncertainty that arises when attempting to determine the exact number of species is due in part to difficulties in determining certain groups of plants and animals, especially in the groups that are excluded from the estimate. Of course, it is also due to the fact that many species that occur in the country only briefly are not always recorded.

Endangered species - the Red Data Book

Status reports on Danish flora and fauna have been prepared at regular intervals over the last 20 years. This work is based on nature monitoring; see Chapter 12.

One vital aid in the conservation of species is the so-called *Red Data Book* of endangered species. The Red Data Book is updated, in part on the basis of the results of our nature monitoring programme. The latest Danish Red Data Book was published by the Ministry of the Environment in 1991; see Box 10.2.

Certain groups (mosses, spiders, snails, etc.) are not listed in the Red Data Book because our knowledge of their present status is incomplete, although we can expect to find them in future issues. Publication of the next Red Data Book is scheduled for 1995.

Fig. 10.1. *Species in the world and in Denmark.*

Group *English name*	*International name*	*Known number in world*	*Known number in Denmark*
Angiosperms	*Magnoliophyta*	250000	1370
Gymnosperms	*Coniferophyta*	600	29
Ferns	*Pteridophyta*	9000	30
Horsetails	*Sphenophyta*	25	7
Club mosses	*Lycophyta*	950	11
Mosses	*Bryophyta*		
Mosses	*Bryopsida*	13000	390
	Andreaeopsida	60	2
	Sphagnopsida	200	40
	Anthoceropsida	300	2
Liverworts	*Hepaticopsida*	7000	150
Stoneworts	*Charophyceae*	400	25
Green algae*	*Chlorophyceae*	1040	82
Yellow-green algae*	*Xanthophyceae*	unknown	13
Brown algae*	*Fucophyceae*	1500	129
Red algae*	*Bangiophyceae*	4000	158
Blue-green algae*	*Cyanophyceae*	unknown	109
Ascomycetes	*Ascomycota*		
Lichens		18000	900
Other A.		15000	2500
Basidiomycetes	*Basidiomycota*	30000	2300
Mammals	*Mammalia*	4200	49
Birds**	*Aves*	9200	185
Reptiles	*Reptilia*	5600	7
Amphibians	*Amphibia*	4100	14
Fish	*Pisces*	21900	166
Tunicates	*Tunicata*	2020	50
Arrow worms	*Chaetognatha*	70	5
Echinoderms	*Echinodermata*	5500	100
Cephalopods	*Cephalopoda*	600	12
Bivalves	*Bivalvia*	8000	87
Scaphopods	*Scaphopoda*	350	2
Snails	*Gastropoda*	38000	230
Chitons	*Polyplacophora*	1000	7
Crustaceans	*Crustacea*	40000	1350
	Entognatha	13500	200
Insects	*Insecta*	950000	18000
Spiders	*Arachnida*	75000	500
Worms	*Vermes*	unknown	2350
Polyps	*Cnidaria*	9000	100
Total		1600000	30000

* The figures include attached marine algae. ** The figure includes breeding birds.

Sources: information from three institutes under Copenhagen University, i.e. Botanical Institute, Botanical Museum and Zoological Museum.

A general survey of endangered plants and animals has been published by the Nordic Council of Ministers during 1995. Denmark has also contributed to an *International Red Data Book for the Baltic Region*, which was published in 1993, and a *Trilateral Red Data Book for the Wadden Sea*.

456 plant and animal species are in immediate danger of becoming extinct in Denmark; see Fig. 10.3. Of these species, amphibians and reptiles account for the greatest proportion of their total number of species in the country whereas, numerically, the invertebrates comprise the greatest number of species. The number of species threatened with extinction in Denmark is at more or less the same level as in many of our neighbouring countries, although it appears to be below the corresponding figures for Europe in its entirety; see Table 10.4.

Box 10.2

Red Data Books

Red Data Books are tools used in nature management, which are intended to draw attention to species that require special consideration. Red Data Books are lists of the extinct, endangered, vulnerable and rare plant and animal species in a geographical area. These books include only species that occur regularly or that occurred in earlier times. Many countries have prepared Red Data Books of their wild plants and animals.

Species are shown in specific categories, in agreement with internationally-used definitions.

- *Ex: extinct species. Species that have become extinct in Denmark since 1850.*
- *E: endangered species. Species that are in danger of becoming extinct in Denmark in the near future, if the deleterious factors affecting them now are permitted to continue to act.*
- *V: vulnerable. Species that are expected to become endangered in the near future, if the deleterious factors affecting them now are permitted to continue to act.*
- *R: rare. Species of which there are only so small or few populations that they are especially sensitive to random variations, variations caused by man, natural variations or acts of carelessness.*

The following two lists have also been prepared together with the Danish Red Data Book.

- *X: require special protection. Relatively common or common species that exhibit a negative population trend or a negative trend in their distribution in Denmark (over 50% reduction since 1960). The trend is still not so serious that they need to be classified in one of categories E, V or R.*
- *A: impose special responsibility. Species for which Denmark, at some time or other in the species', strain's or individual population's life cycle has so large a part of the total population that we bear a special responsibility.*

Categories E, V, R and X are considered to be in special need of protection.

(Source: Ministry of the Environment 1991d.)

Vascular plants

About 1,450 species of vascular plant are described in the latest issue of Danish Flora (1981); see Fig. 10.1. They are flowering plants, conifers and pteridophytes, which can regularly be found free-living and naturalised in Denmark. About 70% of them are counted as being native. Thus, about 1,000 have dispersed to Denmark naturally and have been able to adapt themselves to the conditions of life prevailing here. The latter 30% are species which, after their introduction or advent, have adapted themselves to living conditions in Denmark.

Apart from these 1,450 species, another 270 occur more or less regularly, but which cannot be classified as naturalised. These figures do not include the several thousand species that temporarily go astray and the species that can set seed without prior pollination, the so-called *apomictic* species, such as dandelions and blackberries.

261 native vascular plants require special protection; see Fig. 10.3.

The most frequently-used documentation for changes in our plant life are the changes that occur in the number of habitats. Total counts of entire populations have been carried out for a number of the rarer vascular plants. This gives us a more precise picture of population conditions and fluctuations; see Fig. 10.5.

Many of our native vascular plants are in decline. Thus, meadow, bog, heath and dry-grassland species have become extinct in many habitats, in part because of

Fig. 10.3

Review of the total number of species requiring special protection in 1990 and their distribution over the various categories. Note that a species can easily appear in category A at the same time that it is listed in one of categories E, V or R. A dash under a category denotes that this group of species has not been assessed from the standpoint of the relevant category.

Group of species	Number of species in Danmark	Total „listed" species	%	Ex	E	V	R	X	A
Macrofungi	about 3000	903	30	51	151	309	392	-	1
Lichens	about 900	634	70	85	93	128	262	66	0
Vascular plants	about 1450	261	22	21	40	77	123	-	13
May flies	39	26	67	6	12	8	-	0	1
Stone flies	25	17	68	3	5	9	-	0	1
Caddis flies	166	61	37	9	7	11	30	4	0
Beetles	about 3600	1074	30	148	121	292	291	222	6
Butterflies76	28	37	8	5	13	2	-	0	
Burnet moths	8	8	100	1	0	7	0	0	0
Black flies	23	10	43	0	4	4	0	2	1
Freshwater fish	37	21	57	4	3	3	5	-	6
Amphibians	14	14	100	0	1	3	1	9	0
Reptiles	7	3	43	2	0	0	0	1	0
Birds	about 185	97	52	15	11	7	36	16	14
Mammals	49	19	38	0	3	9	4	3	1
Total	9500	3176	34	353	456	880	1146	323	44

Ex = extinct, **E** = endangered, **V** = vulnerable, **R** = rare, **X** = require special protection, **A** = impose special responsibility. (Source: Ministry of the Environment 1991d).

Table 10.4
Percentage and numerical distribution of endangered species in Europe and in Denmark, analysed for selected groups.

Flora/fauna	Europe			Denmark		
	No. of species	Endangered species		No. of species	Endangered species	
	total	**%**	**total**	**total**	**%**	**total**
Vascular plants	6000	20	1200	1450	3	40
Invertebrates	60000	10-20	6000-12000	21000	1	154
Amphibians & reptiles	>130	>50	>65	21	14	3
Freshwater fish	200	50	100	37	3	1
Birds	700	7	49	about 190	6	11
Land mammals	120	50	60	46	4	2
Marine mammals	30	about 50	about 15	3	3	1

(Source: figures from CEC and Ministry of the Environment 1991d.)

changes in those habitats. However, there is reason for hoping that this decline has been halted as a result of the Nature Protection Act, one of the reasons for which is to ensure the protection of precisely these nature types (which are mentioned in Chapter 7).

The Ministry of Environment and Energy has regularly published *Botanical Sites in Denmark* (from 1976 to 1994), a report, *Status of Danish Flora* (1993) and another report entitled *Status of Botanical Sites and their need for Management* (1994); see also Chapter 12. A popular booklet is being published in 1995, *Protected Plants in Denmark.*

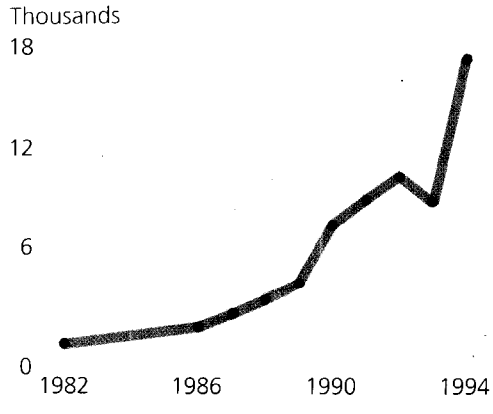
Apart from the naturalised species, more than 20,000 other plant species are to be found in gardens, parks, market gardens and agriculture. Some of them could become naturalised in the course of time.

Mosses
About 580 species of moss occur in Denmark; see Fig. 10.1. A Red Data Book is being prepared for this plant group.

Many species of moss are associated with damp places, such as bogs and flushes. Eutrophication, draining and cultivation have impaired, and reduced the numbers of, these species' habitats.

As examples of moss localities especially worthy of conservation can be mentioned the so-called *paludella springs*, i.e. flushes characterised by the rare and endangered Paludella Sqarrosa; see Fig. 10.6.

Fig. 10.5
Bird's eye primrose. Count of individuals, 1981-1994, in Zealand population. Source: Vesselbo, 1994.



Lichens

About 900 species of lichen occur in Denmark; see Fig. 10.1. 634 are in special need of protection; see Fig. 10.3. This makes the lichens the Danish plant group that contains the greatest number of endangered species.

The most important causes of the threat to many lichen species are the change in and rationalisation of forestry, and air pollution in urban areas; see Chapter 9.

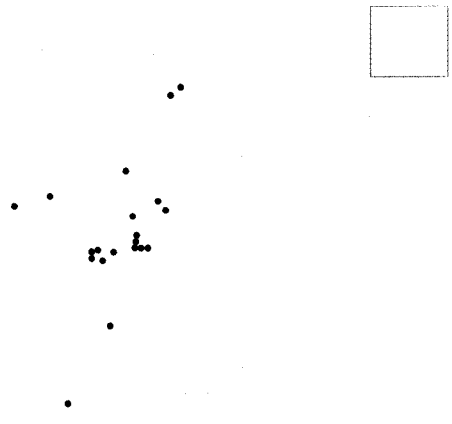
Macrofungi

About 3,000 species of macrofungi have been found in Denmark; see Fig. 10.1. Apart from the monitoring that the Red Data Book constitutes, there is no monitoring of macrofungi (Fig. 10.3) and no status information is available on them.

Denmark has a special international responsibility for Aurantioporus alborubescens, which - apart from a few sites in Denmark - is only found in France.

The decline of many fungi is primarily due to the modification and rationalisation of forestry, one effect of which is that the quantity of dead wood left in our forests is decreasing.

Fig. 10.6
Flushes are now only to be found at 19 sites in Denmark. Source: Ministry of Environment and Energy 1994a.)



Algae

There are at least 450 algae species in Danish fresh- and salt waters; see Fig. 10.1. In addition, there is an unknown number of single-celled plankton algae. New species of algae are introduced now and then by marine currents, birds and shipping. No Red Data Book has been prepared for this plant group.

Algae are used as indicators of water pollution, and many clean water species have declined quite dramatically in our fresh- and salt waters. This applies to both microscopic plankton algae and macroscopic algae.

In cooperation with Copenhagen University, the Ministry of Environment and Energy published a book entitled *Danish Marine Algae - Their Distribution and Danish Names* in 1994, which gives such information as the areas of our territorial waters in which these marine algae were recorded.

Mammals

49 species of wild mammal occur in Denmark; see Fig. 10.1. 19 of them are listed in the Red Data Book as being in special need of protection; see Fig. 10.3.

Denmark has a special international responsibility for protecting grey seal, otters and pond bat. In the rest of Europe, the latter only has viable populations in Holland and Russia.

The most recent general survey of Denmark's mammals is from 1993. This report is based on statistics of the annual game bag. The individual species' advance and decline can, to some extent, be read from these figures.

In recent decades it has been observed that raccoon, muskrat and raccoon dog, which have not hitherto been known in

The viper is less commonly encountered than it used to be.

Denmark, have moved northwards in Germany and have established themselves in South Schleswig. The raccoon is closest to the Danish border, as it has gained a foothold in the Flensborg area.

In conjunction with the adoption of the *small whale agreement* under the Bonn Convention (for the protection of migratory species), the Ministry of Environment and Energy participated during the period 1993 to 1995 in a major programme for mapping the distribution and density of the approximately 25 whale species that probably occur more or less frequently in the North Sea, Kattegat and Baltic Sea.

Birds

209 breeding-bird species are known in Denmark, of which around 185 breed regularly; see Fig. 10.1. 97 are in special need of protection; see Fig. 10.3.

Denmark has international responsibility for protecting populations of the bird species that migrate through, or overwinter in, the country. 11 of these species are designated as imposing special responsibility; see Fig. 4.4.

A report from the end of the 1980s, which shows the number of breeding birds in Denmark, shows that there are about 15 million bird pairs, i.e. about 30 million adult birds. In other words, our avian density is about 700 birds/km″ - at certain times of the year, at any rate. This density of individuals is quite comparable to the individual density in an untouched tropical rain forest in which, on the other hand, the number of species is far greater.

The same report also shows that one third of the breeding species is advancing, one third is stable and the remaining third is in decline. Of the aquatic birds, the species that are in decline are those that migrate over long distances (overwinter in Africa), those that breed slowly and those that occur in wetlands in which the water is very shallow, or in meadows.

New breeding birds are still arriving in Denmark. Since the 1960s, 10 species of bird that all breed here now have migrated naturally into the country.

A far greater number of species has been observed on a few occasions, ranging around Denmark. Escaped cage birds also occur, although they only survive for a short period.

In 1992, the Danish Ornithological Society issued *Danish Birds - a review* which gives, for instance, the status and occurrence of all species recorded in Denmark. A report entitled *Status of Endangered and Rare Danish Breeding Birds, 1976-91*, which was published by the Danish

Ornithological Society and the Ministry of Environment and Energy in 1995.

Reptiles and amphibians

5 species of reptile live in Denmark; see Fig. 10.1. Grass snakes used to be very common but they are now declining rapidly, for which reason they are classified as requiring special protection; see Fig. 10.3. Population changes are not so obvious in the case of the other four species. However, vipers and sand lizards have generally become less common and are on the way to disappearing from some parts of the country.

14 species of amphibian live in Denmark; see Fig. 10.1. Five of them are listed in the Red Data Book as requiring special protection; see Fig. 10.3.

The amphibians are one of the most endangered animal groups here. A number of amphibian localities were studied in the 1940s. When revisited, it was noted that all species showed alarming declines over the period 1945 to 1980. During the same period, the number of sites of occurrence had also dropped dramatically, for instance, as a result of the heavy pollution or destruction of wetlands. This has meant that many local populations are now extinct and the numbers of individuals in the remaining populations are significantly reduced.

Over the five-year period following the latest status report (1988), an extensive monitoring and rescue programme was carried out on behalf of the rarest and most endangered species of amphibian. In the case of the 5 species requiring special protection, we now have approximate totals for the numbers of breeding ponds and the numbers of adult individuals.

This target-oriented effort, which has the form of establishing and cleaning breeding ponds, together with breeding and re-introduction programmes, has generally turned the negative trend for fire-bellied toads and Alpine newt into an advance. This also applies to some extent to green tree frogs.

For the common species, no purposeful effort has been started to improve their conditions of life, and their decline has accelerated over the last 10 years. The moor frog appears to be suffering an especially sharp decline. Several of our counties give economic support for the establishment of new ponds and for cleaning old ponds, in part to safeguard the habitats of amphibians.

Fish

38 species of native freshwater fish have been recorded in Denmark since 1950; see Fig. 10.1. Another 9 species, which have been introduced and released or have escaped from fish farms, have also been recorded. 11 species of freshwater fish require special protection; see Fig. 10.3. No status information has been prepared for the cyclostomes (three species of lamprey).

Of our sea fish, about 220 species have been recorded, of which about half do not breed in Danish waters and should be considered as more or less rare guests; see Fig. 10.1. No status information has been prepared for sea fish.

The latest report of Danish watercourses containing fish was carried out in 1982, as a cooperation between the Ministry of the Environment and the Danish Angling Association. In 1984, the Ministry of the Environment and Århus Natural History Museum mapped fauna interests in Danish watercourses.

The Danish Institute for Fisheries Research carries out continuous mapping, and therefore monitoring, of the fish fauna in our present and potential watercourses for salmonids, in connection with its preparation of plans for releasing salmonids. County watercourse departments carry out regular recording of the occurrence of freshwater fish.

There is no reason for assuming that commercially-exploited sea fish are threatened with extinction in the absolute sense. They are all the subject of

monitoring and, in many cases, of regulation. However, a number of local populations, of herring and salmon in particular, have become extinct during this century. The impact of this on genetic biodiversity and what can be done to help increase fish populations is discussed in Chapter 11.

Invertebrates

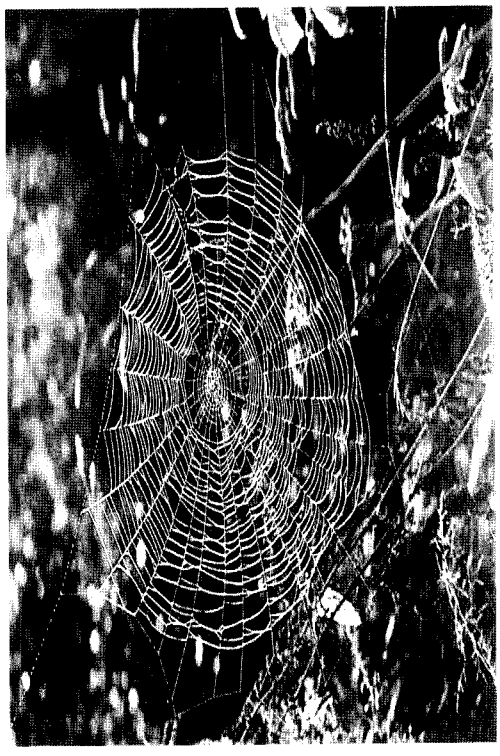
This group of invertebrates has by far the greatest number of species but it does not enjoy a corresponding degree of attention to that given to the other groups of animals. The invertebrates are a very ancient group (perhaps over 2 billion years old). Our knowledge of many genera is limited in comparison with the higher animals, not only from the standpoint of their living patterns and range, but also of the threats to them.

According to one cautious estimate, there are at least 21,000 species of invertebrate in Denmark, of which about 18,000 are insects; see Fig. 10.1. Many species have highly specialised requirements on their habitats, which is a contributory cause of the high number of species.

Due to their size and appearance, however, the status of individual groups of insects is well known. 10 of Denmark's 73 native species of butterfly must be considered to be extinct. 7 species are on the verge of extinction and 18 species are in a general state of decline. Almost all of the decline in the Danish butterfly population has occurred after 1950. No new species have been able to establish themselves here since 1950 and only 3 species have increased their range. In general, the decline of butterflies must therefore be considered to pronounced.

821 species of insect are listed in the Red Data Book, while 228 species require special protection and 9 species are considered to impose special responsibility; see Fig. 10.3.

New species of invertebrate arrive constantly. Some are brought by the wind, whereas others arrive in goods transports, especially of food, fruit, vegetables and soil. Individual species have been able to gain a foothold and have spread vigorously.



Cobweb of Garden spider

Changes in assemblage of species

Although the number of species in Denmark is fairly constant (and even increasing, as far as some groups are concerned), the assemblage of species has changed over the course of time. Several native species are in decline, or are perhaps extinct. This applies, for instance, to such orchids as the frog orchid and lady's tresses.

The constant number of species does not necessarily reflect the dramatic decline suffered by certain species in the number of populations or of individuals in each population. The amphibians are good examples of this.

Changes in the assemblage of species over the past couple of hundred years should be seen in the light of the decline in the number and range of our more unusual nature types, which are the habitats of the specialised species. Drops in the level of the water table, changes in farm operation and the effects of chemicals on the environment have caused many changes; see Chapter 7.

Other species, introduced or adventive, are advancing. This concerns species that are able to survive under differing conditions of life, such as the brown rat.

Man plays a major part in the more or less *involuntary* introduction or advent of plants and animals. The seeds and spores of plants are often spread over wide areas in step with the increase in travel and trade between countries and continents. Vehicles and transports of soil and animals help to spread seeds and spores over short distances. On the other hand, the plants introduced by agriculture have helped to increase the diversity of species on agricultural land, with the concomitant potential for more varied animal life.

As a result of the introduction and advent of new species, the total number of species in Denmark could scarcely have been higher than it is just now. But they are to a great extent precisely the same species that are entering many other countries. Species that could be a beneficial contribution to the diversity of our local assemblage of species do not represent a corresponding contribution to the overall global diversity of species - rather the opposite. The introduction and advent of new species can have an impact on native species - as can be seen in the case of the giant hogweed and ground elder; see Box 10.7.

There are many examples of ecological damage caused by adventive organisms, such as Dutch elm disease, the attacks of Colorado beetles on potatoes and of nun moth on coniferous trees. The delicate balance that has hitherto prevailed is quickly disturbed - often to the accompaniment of major economic loss.

It is worth noting that, in itself, the number of species says little on the ecological success of nature management. It is, of course, necessary to include the relationship between the frequency of species, the trends in external factors and the conditions in the habitats of the species. It is also necessary to conserve the biodiversity that is already present in an area.

Introduction and use of alien species

Man has, more or less deliberately and with varying degrees of success, introduced a number of plant and animal species into Denmark from other parts of the world.

During the establishment phase, non-native species will compete for habitats with the wild native species. If an alien species is better able to compete, it will then present a threat to local wild plant and animal life by taking over the habitats of one or more of the native species. Examples of this are the Japanese rose, ground elder, giant hogweed and the spreading of the seeds of introduced coni-

Box 10.7

Article 8h of the Convention on Biological Diversity, 5 June 1992:

„Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;"

ferous trees to areas covered by native, phototropic herbal vegetation, such as the spreading of the mountain pine in dune heath areas.

In some cases, introduced species have found a niche that none of our native species has so far been able to fill. These species, such as the pheasant, can thus become a part of Danish nature on an equal footing with native species; see Box 10.8.

When introducing alien plants and animals, there is always a risk that they carry infectious diseases, which could pose a threat to our agricultural crops, the trees of the forests, domestic animals, wild plant and animal life and people.

Introduced, injurious animals are often associated with a specific native plant or animal species, either for food or as a host organism. The native species is thus exposed to considerable pressure which, in the worst case, means that it becomes extinct at the regional or even national level. Globally, the introduction of alien plants and animals has been one of the main causes of the extinction of native species, e.g. on small islands.

One example of a native species that can be threatened by an introduced species is the relationship between our native crayfish and North-West American signal crayfish. These two species of crayfish occupy largely the same ecological niche and will therefore compete, if signal crayfish are released in a native crayfish population. Although they can co-exist for some time, Swedish experience suggests that, because of its better competitive abilities, the signal crayfish will gain the upper hand. One particularly serious circumstance for our native crayfish is that the signal crayfish can be

Box 10.8

Nature's Asiatic guest

The pheasant comes originally from Asia, from where it has been introduced to other parts of the world, including Europe. It has an astonishing ability to adapt. The history of the pheasant in Denmark goes back to 1562, when an English falcon catcher was allowed to catch falcon in Denmark in exchange for supplying King Frederik the Second with a pair of live pheasants. They were kept in pheasant warrens, as have been all pheasants over the following centuries, during which roast pheasant remained a luxury reserved for the Court. A free-living population was established at Kongelunden, on Amager, in 1840.

By the end of the century, it became increasingly common to establish pheasant warrens on Danish estates. It was just a matter of breeding the game and then releasing it in the countryside in time for the hunt. However, it was not always possible to shoot all of the individuals so released and, in some parts, the surviving birds formed free-living populations, which were artificially maintained in most places by repeated annual introduction. The pheasant spread in this manner, first in the neighbourhoods of estates and then over practically the whole country, as local hunting associations began to release pheasants everywhere, from 1932. The most vigorous populations can be found on the Islands, whereas the weakest are in the leanest parts of Jutland.

Today, such introduction would require a permit under the Act on Hunting and Game Management. (Source: Hvass, 1978.)

the healthy carrier of crayfish disease, which is absolutely lethal to our native crayfish.

A good example of a threat to man himself is the advent of the brown and black rats. Neither of these species is native to Denmark. Since their arrival they have been the direct or indirect causes of the deaths of thousands of people, over the intervening centuries.

Extinct species

According to the latest Red Data Book, 353 native Danish plant and animal species are estimated to have become extinct over the last 150 years.

However, there are certain difficulties in classifying a species as extinct. It can be said that a species is extant if individuals of that species are observed. But it is not certain that a species is extinct merely because no individuals have been observed for a number of years. Certain species of orchid (such as the parasitic ghost orchid, which lacks chlorophyll) and fungi can survive underground for several years, only to reappear when climatic conditions are suitable. Seeds can remain in the soil for many years and first germinate when the soil is disturbed or when germination inhibitors are leached out of the seed coat. In other words, penetrating field studies are needed if we are to be able to state with any certainty whether such species are extant or extinct.

The scope and complexity of studies of individual nature types play a significant part in assessing whether or not a species has become extinct. For instance, special equipment is required to study the bottom of a lake. It is through such intensive studies of fresh waters that we have revealed the occurrence of plant and animal species that were believed to be extinct; see Box 10.9.

The impact of humans has made it difficult for the large mammals to migrate or re-migrate spontaneously into Denmark. For instance, wild boar would be

Box 10.9

Rediscovered

The two species of naiad have only been found a few times in Denmark, at 4 and 2 sites, respectively. The latest finds are from 1969 and 1961. Both species were considered to be extinct in the most recent Red Data Book (1991). It was therefore something of a sensation when both species were rediscovered in 1993. The holly-leaved naiad was dredged up from the bottom of Lake Buresø, when the county of Frederiksborg was studying the lake, and the slender naiad was observed growing in large numbers in about 2 m of water on the bottom of Lake Nors, in Thy.

Just as surprising is the observation that the otter still occurs in Zealand as, in the latest nation-wide survey of its occurrence, it was only observed in Jutland. The county of West-Zealand found otter excrement in a well-known otter locality (which was also investigated in the national survey) at the beginning of 1995. It is probably a question of a small population that has managed to survive in this locality, rather than of a migration.

As the slender naiad and otter are both listed on the EC Habitats Directive's lists of plant and animal species in need of protection, these finds have resulted in proposals to designate the localities in which they were found as EC Habitat Areas.

able to maintain a viable population in the Danish landscape if man would accept their presence.

Endemic species

There are no endemic species (i.e. species that range over a very limited area) in Denmark. The period since the last ice age has probably been too short for the evolution of local species to take place.

However, on levels below the species level, 23 systematically distinct groups, which appear to occur only in Denmark, have been observed. In addition, there are 19 regional species of blackberry. „Regional species" is the name given to species that range only over very limited areas (diameter of between 50 and 250 km). None of the latter species are confined to Denmark. They are also known in Northern Germany or Southern Sweden.

The houting is a salmonid that now occurs only in Denmark and in a few rivers that flow into the Baltic Sea. It was previously common in North-West Germany and Holland. It has been totally protected in this country since 1983. Since then it has been bred and released in River Vidåen, which was the only Danish river in which it still occurred. It was also released in neighbouring rivers in South Jutland. At the same time, spawning grounds and migration corridors were re-established in the watercourses in which the houting had previously lived. The houting population is now considered to be sufficiently viable to survive by itself.

The figures mentioned above are for endemic Danish, or approximately Danish, species, and their systematic levels reflect the lack of specific knowledge of both plants and animals, particularly at the level of the sub-species.

Plans for management of species

Species-management plans describe a species' (or species group's) status and the threats to which it is exposed. The plan examines the potential for preserving the species or for counteracting the problems that it causes. Species-management plans also recommend the means that should be applied for conserving the species. The Ministry of Environment and Energy has prepared species-management plans, or proposals for such plans, for otter, pink-footed goose and the continental cormorant, as well as for amphibians and reptiles.

Current protection performance

Legal protection

The best way to conserve biodiversity is to protect the habitats of the individual plant and animal species and the natural processes of which they are a part. Individual and national species protection, and international protection, are tools that can be used as supplements, in cases where special protection considerations are linked to a species or an entire group of species. One of these is protection against direct intervention, in the form of collecting and hunting, which is the reason why a number of species have been conserved in Denmark.

The protection of mammals and birds is carried out according to the provisions of the *Act on Hunting and Game Management*. These provisions are based on the simple principle that species for which no hunting season is specified are protected. The mammals and birds that can be hunted, and their seasons, are specified in a Statutory Order. Hunting seasons were revised in 1994, pursuant to the Act.

Freshwater and sea fish are protected, for instance, by general provisions on minimum sizes, protected seasons, permissible equipment, etc., in the Freshwater Fisheries Act and Sea Fisheries Act, together with EU fishery regulations. The Minister of Agriculture and Fisheries sets the rules on minimum sizes and the complete or partial protection of specific fish, crustaceans and molluscs. Typically, such protection covers the breeding pe-

Fig. 10.10.
Protected animal (apart from birds, mammals and fish) and plant species in Denmark.

Reptiles	*Reptilia*
Slow worm	*Anguis fragilis*
Sand lizard	*Lacerta agilis*
Common lizard	*Lacerta vivpara*
Grass snake	*Natrix natrix*
Viper	*Vipera berus*
Amphibians	*Amphibia*
Smooth newt	*Triturus vulgaris*
Crested newt	*Triturus cristatus*
Alpine newt	*Triturus alpestris*
Fire-bellied toad	*Bombina bombina*
Common spade-foot frog	*Pelobates fuscus*
Natterjack	*Bufo calamita*
Green toad	*Bufo viridis*
Common toad	*Bufo bufo*
Common frog	*Rana temporaria*
„Moor frog"	*Rana arvalis*
Jumping frog	*Rana dalmatina*
Edible frog	*Rana esculenta*
Marsh frog	*Rana ridibunda*
Green tree frog	*Hyla arborea*
Beetles	*Coleoptera*
„Water beetle"	*Dytiscus latissimus*
„Water beetle"	*Graphoderus bilineatus*
„Hermit beetle"	*Osmoderma eremita*
Stag beetle	*Lucanus cervus*
Dragon flies	*Odonata*
	Aeshna viridis
	Ophiogomphus cecilia
	Leucorrhinia pectoralis
Butterflies	*Lepidoptera*
	Coenonympha hero
Marsh fritillary	*Euphydryas aurinia*
Large blue	*Maculinea arion*
Mussels	*Bivalvia*
Freshwater pearl mussel	*Margeritifera margeritifera*
Leeches	*Hirudinea*
*Medicinal leech	*Hirudo medicinalis*
Snails	*Gastropoda*
*Roman snail	*Helix Pomatia*
Club-mosses	*Lycopodiaceae*
Alpine club-moss	*Lycopodium alpinium*
Quillworts	*Isoëtaceae*
Spring quillwort	*Isoëtes echinospora*
Ferns	*Filices*
Royal fern	*Osmunda regalis*
Spleenwort species	*Asplenium spp.*
	Botrichium simplex
Holly fern	*Polystichum acumleatum*
Hart's tongue	*Phyllitis scolopendrium*
Monocotyledons	*Monocotyledones*
	Iris spuria
	Anthericum spp.
Orchid family	*Orchidiceae*
Floating water-plantain	*Luronium natans*
Dicotyledons	*Dicotyledones*
	Anemone appenina
Marsh saxifrage	*Saxifraga hirculus*
	Pulsatilla vernalis
Marshmallow	*Althaea officinalis*
Bird's eye primrose	*Primula farinosa*
Scots lovage	*Ligusticum scoticum*
Labrador tea	*Ledum palustre*
Narrow-leaved lungwort	*Pulmonaria angustifolia*
	Prunella grandiflora
Broomrape species	*Orobanche spp.*
Horse's tongue	*Mertensia maritima*

*These species must not be exploited commercially.

riods of economically important fish.

The release of fish, crustaceans and molluscs, as well as eggs and fry, is normally prohibited in the sea and fresh waters without a special permit. The underlying reason is to prevent the undesired spreading of alien species and to ensure that fish are released according to plans based on a biological evaluation of the selected area.

The protection of other animal groups and plants is carried out pursuant to the Nature Protection Act. This act also contains provisions on the release of plants and animals in our territorial waters and fishing waters. In contrast to the Act on Hunting and Game Management, the Nature Protection Act does not include any principle through which plants and animals are protected unless their collection and hunting is expressly permitted. Thus, its protection provisions apply only to species listed on a special list in the Statutory Order on the Protection of Species, the latest of which dates from 1991.

Reptiles and amphibians were protected as early as 1980. This was re-affirmed in 1991 and supplemented with the protection of other species. In all, a total of 13 species of invertebrate are protected. 11 are totally protected, whereas two are protected against commercial exploitation; see Fig. 10.10. As far as animals are concerned, the protection provisions mean that adult individuals and their offspring, in the form of eggs, larvae, chrysalises and tadpoles, must not be killed or collected.

In the case of protected plants, the provisions mean that they must not be dug up, picked or otherwise injured, and that seeds and other parts must not be collected. A little over 70 Danish vascular plants are totally protected; see Fig. 10.10.

Denmark's total protection of orchids, Botrychium simplex, floating water-plantain and marsh saxifrage, together with the 11 invertebrates, has meant that Denmark has fulfilled its obligations in relation to the Berne Convention and EC Habitats Directive.

International cooperation on protection of species

Denmark has acceded to a number of international agreements that specify requirements on the protection of species; see Chapter 14 and Box 14.1.

Release of alien species

Pursuant to the Nature Protection Act, the release of alien animal species requires that exemption be obtained from the Ministry of Environment and Energy. The Act on Hunting and Game Management contains a similar provision that applies to birds and mammals. The purpose is to make it possible to assess the consequences of such releases and, thus, to avoid the unfortunate side effects that highly competitive animal species can have on natural habitats.

Although no corresponding exemption scheme has been established where plants are concerned, the Nature Protection Act empowers the Minister to specify such a scheme. Regulation of the artificial introduction of plants would be extremely difficult to manage. It would be more appropriate to provide information on the damage that could possibly be caused by the introduction of alien species.

Forthcoming efforts

Following up legislated species protection

As mentioned above, the main effort for the preservation of endangered species or species requiring special protection is directed towards conserving their habitats. The primary means of doing this now and in the future have already been described in Chapters 4 to 9.

The Nature Protection Act's protection scheme restricts human intervention in some of the wild plant and animal species' habitats. At the same time, the scheme offers broad safeguards for the

operation of natural processes in our protected nature types. Together with Denmark's accession to a number of international conventions, this has meant that our natural native flora and fauna are now the objects of relatively extensive protection.

Little is known, however, of the real significance of the protection scheme to the protection of our wild plant and animal species. It is therefore necessary to conduct studies of the scheme's effects. In the future, the results of such studies can be used when adjusting the protection of habitats that has been implemented so far pursuant to the applicable legislation.

Accumulation of scientific knowledge

Apart from the general protection of nature types and the other measures now being taken to protect the habitats of wild plants and animals, there is still a need to accumulate scientific knowledge in the broadest sense. The fact is that, in the case of several species, including a number of potential indicators, current knowledge is limited or defective. Thus, as mentioned above, their status has not been reported.

There is a need for a special endeavour towards establishing a knowledge base on species that *require special protection* and on species that *impose special responsibility*.

In the case of the invertebrates, in particular, the extremely large number of species makes it important to make a goal-oriented effort. This applies from the standpoint of selection of the species of which status studies should be made, selection of areas that are the habitats of particularly many endangered or rare species and the choice of indicator species for use in monitoring projects, etc.

A set of methodological guidelines for the monitoring of insects was published in 1995. It is important to start pilot projects that test the methods recommended in the guidelines. It will then be possible to start permanent monitoring of insects using the methods found most suitable according to the results of the pilot projects.

It is important to include consideration for the invertebrates in other nature protection measures, so that this is also included in the assessment of projects on the same lines as other plant and animal species. Examples of such measures are the Natural Forest Strategy, nature management projects, conservation projects and conservation action plans.

It is also necessary to supplement and revise the collection of good Danish identification handbooks for flora and fauna - especially those that deal with the less well-known plant and animal groups.

In this context, a working group has been appointed within the framework of Nordic cooperation. This working group has the task of assessing the need for revising our identification handbooks for flora and fauna and of deciding which resources will be needed to satisfy these needs.

As far as the vascular plants are concerned, a Nordic scientific cooperation has been launched in connection with the publication of a flora that covers all of the Nordic countries. The first of the four volumes of *Flora Nordica* is expected to be issued during 1996.

Monitoring of species that require special protection and species that impose special responsibility

Much information on the ranges and population sizes in Denmark of many wild plant and animal species has been acquired over the past 20 years. It primarily concerns mammals, birds, reptiles, amphibians, fish and vascular plants. This information is used as the basis for preparing a Red Data Book and management plans for the individual species.

Human intervention has the effect that the conditions of life of many plant and animal species are still changing. Documentation of such change must be

acquired through monitoring programmes. There is, therefore, still a need for regular monitoring, especially of *species requiring special protection* and *species that impose special responsibility*, in order to gain information on their current status. Should it prove that these species are declining, there is a possibility that we can halt the process.

Revision of Red Data Books
One vital instrument in this context is Denmark's official list of species requiring special protection - the Red Data Book. This should be revised every 5 years in future, on the basis of regular assessment of the status of the Danish flora and fauna.

Species-management plans
It is also important that work be continued on species-management plans for species in all plant and animal groups - especially those that impose special responsibility. This will provide us with the necessary tools for ensuring the continued well-being of these species and for resolving conflicts with other interests.

Later, when the final plans are available, it will be possible for the State, counties and districts to aim their efforts for the conservation of specific species or for improving specific areas, on the basis of a nation-wide viewpoint and strategy. This will enable us to safeguard viable populations of all species in the country, even if populations will, in some cases, be smaller than was previously the case.

To protect natural native plant and animal life still further, present methods of target-oriented protection against unfortunate competition from introduced species, such as the giant hogweed, should be assessed and further developed. Similarly, we should prepare strategies for restricting aggressive or disease-bearing alien plant and animal species that have already been introduced.

Operation and nature management
The importance of starting or supporting the correct form of operation and management of several of our semi-natural nature types, to safeguard them, e.g. against overgrowth due to the cessation of grazing, is discussed in Chapter 7. This will safeguard the conditions of life of many phototropic species of vascular plant, moss and invertebrate.

Multi-faceted forestry
The significance of re-introducing multi-faceted forestry and laying out of natural forest areas has been mentioned in Chapter 8. Many species of fungus, invertebrate and bird are dependent on forests of variegated composition, with a number of dead trees left untouched. It is therefore vital that the intentions of the *Strategy for Sustainable Forestry* and *Natural Forest Strategy* be implemented in practice.

Since most of the lichens that require special protection are to be found in forests, the implementation of multi-faceted forestry and the Natural Forest Strategy (see Chapter 8) will contribute to improving their status. One reason for this is that the lichens in forests are better protected against air pollution than those in the open countryside.

By far the greater part of the fungus species listed in the Red Data Book are confined to forests. It is therefore important that the Forest Act's provisions on multi-faceted forestry win a breakthrough in the management of Danish forests and that the Natural Forest Strategy be implemented. This will safeguard most of the endangered fungi.

Establishment of fauna passages and ecological corridors
The establishment of fauna passages in association with present road installations and weirs has helped to halt the decline of several mammals, such as the otter. Therefore it is important for future planning of such installations to give

consideration to the establishment of fauna passages and their associated ecological corridors in connection with animal passage and migration routes, for instance, along watercourses. Similarly, it is important to establish free passage for the creatures of the watercourses where such barriers as dams are created.

The intersection of natural areas should be avoided as far as possible, as the establishment of fauna passages is not always the optimum solution to the barrier problem, since most types of barrier present many problems.

International cooperation

International cooperation makes it possible to draft agreements in accordance with the Bonn Convention on migratory species that are not associated with a single country. As has been previously mentioned, such agreements have been drafted to cover small whales in the Baltic Sea and North Sea, for European bats and for seals in the Wadden Sea. An agreement on the protection of migratory aquatic birds is in preparation.

It is important to continue and expand international protection efforts, so that migratory species are ensured summer and winter resting places along their routes. To the extent that developing countries are to be involved in international agreements on this, the Convention on Biological Diversity and the Global Environmental Facility (GEF) open up new opportunities for giving financial support.

More direct cooperation should also be established - possibly in the form of aid programmes - with the countries that *receive* Danish migratory birds, typically in Africa, because of the many Danish bird species that are, in fact, migratory birds. Such cooperation has already started slowly between the countries around the Wadden Sea and Guinea-Bissau; see Chapter 12.

Recommendations supported by Denmark, on the protection of individual species, species groups and nature areas, have been adopted under the *Berne Convention*. This will continue to be an important tool in international cooperation on improving the protection of species and their habitats.

Similarly, the *EC Habitats Directive* will probably also prove to be a valuable instrument in safeguarding species and their habitats, in conjunction with the designation of the international network of conservation areas in member states. As has been mentioned in Chapter 4, for instance, the Ministry of Environment and Energy is preparing a proposal for the designation of Danish protection areas and will ensure that its recommendations are implemented.

One development of botanical protection work is to ensure that relevant species, including those that impose special responsibility, are included in the international nature protection conventions that have been of such vital significance to the species involved.

Public presentation

A number of goal-oriented initiatives concerned with the protection of frogs and their habitats, the protection of orchids on the island of Møn and the Storstrøm Local Council's project, *„Adopt a Wild Flower"*, have already proved their worth by increasing Danes' understanding for Denmark's natural assets. Informative work on especially vulnerable and protected species should, therefore, continue and be extended to cover species that impose special responsibility.

There is also a need for giving Danish names to species - to the extent that this is reasonable - in order to heighten people's knowledge of the less well-known plant and animal groups; see also Chapter 13.