BIRDS OF ETHIOPIA & ERITREA

John Ash & John Atkins

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Birds of
ETHIOPIA AND ERITREA
an atlas of distribution

John Ash and John Atkins

with contributions from
Caroline Ash, Sue Edwards, Chris Hillman, Geoffrey Last and John Miskell

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PREFACE

The avifauna of Ethiopia and Eritrea, more than 870 species, is known for its endemics, many common and easy to see, such as Spot-breasted Plover, Rouget's Rail and Thick-billed Raven. The waterbirds of the Red Sea coast and the Rift Valley lakes are spectacular in their beauty and numbers. The birds of the highlands and montane areas are often tame and easily observed, including the isolated and endangered population of Wattled Cranes, probably representing an undescribed subspecies. The avifauna of these two nations is indeed special.

I had the good fortune from 1964 to l975 to reside in Addis Ababa, travel widely in Ethiopia and Eritrea and study the birds there. Over the years I have managed an ongoing interest in ornithological research in this area of Africa, and it now gives me great pleasure to see the publication of the definitive work, *Birds of Ethiopia and Eritrea* by John Ash and John Atkins.

Both authors are eminently qualified to prepare this book. John Ash lived in Ethiopia from 1969 to 1977, working with the US Naval Medical Research Unit (NAMRU). Much of the information of this book comes from John's studies at NAMRU on the role of migrating and resident birds in the dissemination of arboviruses. He spent weeks and weeks at a time working in the field observing and ringing thousands of Palearctic and Afrotropical birds and checking them for arboviruses. Co-author John Atkins, working at Addis Ababa University on an educational project from 1991 to 1996, became actively involved in the Ethiopian Wildlife and Natural History Society. He inspired students to become involved in conservation activities and studying birds. He also encouraged nearly every ornithological visitor to the area to make available their records for this book on the birds of Ethiopia and Eritrea.

Land degradation in Ethiopia and Eritrea, as in many areas of Africa and the world, is expanding at an alarming rate. Many factors are contributing to this, including an increase in human population. In a part of the Rift Valley very special to me, the Abiata-Shalla National Park, where I spent many years studying pelicans, cormorants, ibises and wildfowl, the human population more than doubled in 30 years. In 1975 about 9000 people with 44,000 cattle, goats, sheep and equines lived in the park, while in 2000, 25,000 people with 77,000 domesticated stock lived there (Feyera Senbeta and Fekadu Tefera, *Walia* 22: 28–36, 2001–2). This expansion in numbers has resulted in a need to produce more food, which in turn has resulted in overgrazing, soil degradation, wetland loss, and woodland and forest destruction. These factors, aggravated by climate change, cause general habitat loss and a corresponding reduction, even possible extinction, of some of Ethiopia's and Eritrea's special birds.

Since birds are often easily seen and easily assessed, they are good bio-indicators of the health of habitats. To monitor these habitats, a detailed knowledge of the range and status of birds of Ethiopia and Eritrea is essential. Ash and Atkins' book will provide this information and in turn will be a key tool for conservation activities. Further, it will motivate ornithologists and tourists to visit and explore this fascinating part of Africa.

Emil K. Urban

FOREWORD

The number of species of birds found in Ethiopia and Eritrea is high, and includes many endemics. This is to be expected in a situation where the plateaux of both countries are much dissected, producing a wide variety of ecological conditions. Altitudes range from 100m below sea-level to nearly 5000m above sea-level. This results in wide temperature ranges in an environment where rainfall varies from as high as 3000ml down to nearly none at all in a year.

Among birds, francolins and guineafowl suffer from some hunting pressure, but no other species are hunted. I doubt whether any Ethiopian rural boy ever escaped from being smacked if he ever stoned birds or threatened them in any other way. Crop pests, such as queleas and weaver-birds, are the only birds frightened away from farmers' crops. This positive attitude towards birds is unlikely to change in the future, provided current religious beliefs continue.

The environments of both countries are relatively free from those pesticides which have a tendency to build up in the food-chain, so this increasingly common threat to birds of prey elsewhere is hopefully less likely to arise in our region. Nevertheless many species of raptors have decreased in recent years, and some, such as the impressive Lammergeier, once quite common, are now infrequently seen. In some parts of Africa overhead high-tension wires have been recognised as causing alarmingly high mortality among some raptors. This situation may need more attention, although with a global ban on the manufacture and use of certain organochlorine pesticides being brought about by the Persistent Organic Pollutants (POPs) Convention, hopefully the situation will continue to improve in the indefinite future in the two countries here.

I am not an optimist when it comes to other pollutants that could affect birds and other animal species. Both Ethiopia and Eritrea are trying to industrialise, and the risks of increased pollution are going to grow with time. On the other hand environmental awareness is also growing, and hopefully we will avoid the majority of pollution problems that have bedevilled the countries that pioneered industrialisation.

Climate change, however, seems now to be globally inevitable. There is no doubt that substantive changes in climate will affect the distribution of birds, as well as the activities of man. Particularly vulnerable will be the very high mountain bird species since they would not have the niches that could sustain them, as there will be no higher ground to which they can escape.

This present book showing the identity and distribution of the birds in our region will, therefore, serve two obvious purposes: it will allow us to see what future changes in bird distribution could be taking place and alert us to which factors may be involved, and challenge us to identify the corrective measures which will need to be taken to save endangered species from extinction. This, in turn, will force us to give the necessary attention our environment will require so that it can continue to sustain us.

The book will also serve the obvious purpose of informing readers of what they see. Tourism is growing fast in Ethiopia, and this book will be invaluable to the ever-increasing numbers of nature-loving tourists, birdwatchers and ornithologists visiting our region. Both the authors are my old friends, and I thank them very much for this most useful reference book, which has taken many years of painstaking observation, reading, writing, and the immensely tedious task of checking and counter-checking.

Tewolde Berhan Gebre Egziabher
Addis Ababa

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A GENERAL INTRODUCTION TO THE REGION

Location

The region comprising Ethiopia and Eritrea lies in the Horn of Africa. Ethiopia, previously Abyssinia, the land of the Habasha (Amharic for 'mixture'), lies between 3° and 18°N and 33° and 48°E. It has an area of 1,133,380km^2 and is bounded in the south by Kenya, in the west by the Sudan, in the east by Somalia and Djibouti, and in the north by Eritrea. In 2007 it had an estimated population of *c.*77 million, of whom *c.*4.5 million live in the capital Addis Ababa. Eritrea, named after the Red Sea (*Mare Erythraeum* in Latin), lies just to the north and along the west coast of the Red Sea, covering an area of 125,000km^2. It is bordered to the north and west by Sudan and to the south by Ethiopia and Djibouti. Its estimated population in 2007 was 4,906,585, of whom *c.*500,000 lived in the capital, Asmara. The administrative regions and major towns of the two countries are shown in Figures 6a and 6b and the pre-1991 administrative boundaries in Figure 7. The international borders indicated on these and other maps have no official status.

Topography

This is a region of great geographical diversity, characterised particularly by altitudinal variation, from 110m below sea-level in the Dallol Depression to 4620m at Ras Deshen in the Simien Mountains. The plateau has many mountainous areas rising to higher than 4000m. The region contains more land above 2000m than any other African country (Yalden 1983), with two main blocks of high land, the western and northern highlands and the south-eastern highlands, separated by the Rift Valley. The main topographic regions of Ethiopia and Eritrea are indicated in Figure 8. In Ethiopia these are: the main highland plateau to the west of the Rift Valley and the Danakil Desert (also known as the Afar); the south-eastern highlands to the south and east of the Rift Valley; the western lowlands bordering Sudan and extending south to the Omo valley; the south-eastern lowlands of the Ogaden and the Somali border; the southern lowlands of Ethiopia including the lower Omo valley; the eastern lowland desert and semi-desert lands of the Danakil (Afar) south to the Awash river; and the Ethiopian Rift Valley. In Eritrea, the main topographic regions are the western lowland plain along the Sudan border, with the only year-round river, the Tacazze/Setit; the central highland plateau below the Sahel in the north, extending south to the highlands of northern Ethiopia; the north-eastern desert plain and Danakil Desert; and the coast and offshore islands. The principal river systems, all flowing from the highlands, are the Tacazze/Setit/Angareb system, the Abay (Blue Nile) system, the Awash, the Wabe Shabeelle, the Genale/Dawa/Weyb system, the Omo/Gibé system and the Baro/Gilo/Akobo system. In addition there are a number of large lakes in the Rift Valley, Lake Tana in the north-west and the northern tip of Lake Turkana in the south-west. The main wetlands, lakes and rivers are shown in Figure 14. See the Topographic Regions and Hydrography chapter for further information.

Languages and peoples

The region is marked by ethnic and linguistic diversity, with estimates of up to 100 languages, but there are generally considered to be 70–80. Major ethnic groups in Ethiopia are the Oromo (40%), Amhara and Tigrean (32%), Sidamo (9%), Shankalla (6%), Somali (6%), Afar (4%) and Gurarge (2%), with c.70 languages being spoken between them, most of them either Semitic or Cushitic in origin. The language of the Ethiopian Orthodox Church liturgy, Ge'ez, gave rise to the Semitic cluster of languages, Amharic, Tigrinya and Tigre. Amharic is the official language of Ethiopia. However, many of its regions also use the dominant local language in local government and education, with Amharic remaining the *lingua franca* of the country. Cushitic languages are spoken in the south, the most significant being Oromigna, spoken by Ethiopia's largest ethnic group, the Oromo. Further south is a range of c.25 Omotic languages. Arabic is spoken in many lowland areas and is widely used by followers of Islam. The main religions are Ethiopian Orthodox Christian (35–40%) and Islam (45–50%).

There are nine main languages in Eritrea, the most common being Tigrinya in the highlands and Tigre and Arabic in the lowlands. The Tigray people comprise 50% of the population and the Tigre 35%. The population is half-Christian and half-Muslim. The Julian 13 months' calendar is used in Ethiopia, but Eritrea has adopted the European 12-month calendar.

History

The region has a significant place in pre-human history: hominid fossil bones, including the australopithecine 'Lucy', dating back 4.4 million years, have been found at Hadar along the Awash in Ethiopia and evidence of pre-humans dating back 1 million years has been found in the Buia region of Eritrea. Human presence is known from the eighth millenium BC with evidence of Pygmoid, Nilotic, Cushitic (Afar) and Semitic (Amhara and Tigray) peoples.

The origins of the modern-day region lie in the emergence, by the third century AD, of the Axumite empire, which soon became officially Christian. In ensuing centuries the respective and often conflicting influences of chiefly Muslim interests on the coast and lowlands and Christian (Ethiopian Orthodox) interests in the highlands were not conducive to any state of unity. During a period of great instability in the sixteenth century the Galla people (the present-day Oromo) moved out of the south, up through the Rift Valley onto the higher ground of southern and central Ethiopia. During the mid-eighteenth century the region became increasingly restless as a result of feuding societies of Christians, Muslims and others, and their local rulers. Today's Eritrea was sometimes ruled by the Ethiopian highland empires and at other times separated from them. The coast remained Muslim, and between the sixteenth and eighteenth centuries was controlled by Ottoman Turks and Egyptians. Some degree of unification and modernistic development began to develop during the mid-nineteenth century.

In the nineteenth century the region became a focus of Italian colonial aspirations, and in 1890 the colony of Eritrea was established. In 1935 Italy occupied Ethiopia, but was defeated by combined Ethiopian and British forces, who returned Haile Selassie to his throne following the outbreak of World War II. Eritrea was ruled by the British until 1952, when the UN declared the country a self-governing region under the mandate of Ethiopia. Haile Selassie's reign was ended by a coup led by a military group, the Dergue, in 1974. However, its Soviet-style socialist policies were unpopular, and it collapsed after a long war in 1991, at which point a broad-based coalition was established in Ethiopia. These events also led to the end of Ethiopian rule in Eritrea and eventually to Eritrean independence in 1993, after 30 years of war.

Economies

The economies of both countries are predominantly agricultural and have been much disrupted since the 1970s by a combination of factors which have included accelerating population growth, drought and famine, war and internal security problems, land-reform programmes, nationalisation, and increasingly less favourable terms of trade. Coffee has traditionally accounted for the majority of Ethiopia's exports. Explorations for oil and gas are taking place in Somali and Gambella regions in Ethiopia and both are expected to become major export earners. There are believed to be other substantial unexploited mineral deposits in both countries, particularly copper and potash. Important products of the Eritrean economy include salt and leather products, grain, cotton, fish, livestock, various minerals, etc. There are substantial tourist potentials, still largely untapped, especially in wildlife and ecotourism, in both countries. Infrastructure, transport and water supply all require urgent attention, but none of these tasks can be seriously tackled without effective population control programmes.

Governments

The Federal Democratic Republic of Ethiopia, established in 1995, comprises nine semi-autonomous states and two chartered cities (capitals or main towns in parentheses): Tigray (Mekele), Afar (Aseita), Amhara (Bahar Dar), Oromiya (Nazret), Somali (Jijiga), Beni Shangul-Gumuz (Asosa), Southern Nations, Nationalities and Peoples (Awassa), Gambela (Gambela), Harari (Harar), Dire Dawa and Addis Ababa (chartered cities). Executive powers are vested in the Prime Minister. Each state is divided into 'woredas', the lowest level of official government. Each woreda also carries one parliamentary seat in the House of Representatives. Local government organisation through locally elected officials resides with the 'kebeles'. Responsibility for setting the policy environment for the conservation and sustainable use of natural resources falls under the Environmental Protection Authority at the federal level, but implementation is carried out by the regional bureaus and experts in each woreda. The Ministry of Agriculture and Rural Development has overall responsibility for the development of all the cultivated resources, wildlife and forests of the country.

The government of Eritrea includes a national assembly and a cabinet responsible to the national assembly. There are six regional administrative zones or 'zobas' (main cities/towns in parentheses): Semenawi Keyih Bahri or Northern Red Sea Zoba (Massawa, Nakfa), Maekel or Central Zoba (Asmara), Debubawi Keyih Bahri or Southern Red Sea (Assab), Debub or Southern Zoba (Adi Ugri, Mendefera, Adi Quala), Gash-Barka (Barentu, Agordat, Tessenei), Anseba (Keren). Responsibility for the conservation of natural resources is under the Ministry of Agriculture, the Ministry of Fisheries and the Ministry of Land. Efforts are underway to develop government structures for implementing biodiversity conservation policies.

Environment

Throughout its history, the environment of the region has been under pressure. It is known that during the time of the Axumite Empire, from the third century BC to approximately the tenth century AD, special areas were designated for hunting, and wild animals and animal products were actively traded. However, little evidence of other forms of environmental conservation practices exists, and for centuries wildlife and forests have come increasingly under pressure from population movements and population growth.

The causes of the drought, disaster and human suffering experienced in Ethiopia in recent decades lie partly in the natural environmental factors that have resulted in land degradation, partly in population growth factors that have in many areas resulted in populations exceeding the carrying capacity of the land, and partly in the neglect of smallholder farmers and their environments by the feudal government of Emperor Haile Sellassie, and the misguided Soviet-style development efforts of the Dergue, a deterioration which started in the deliberate undermining of the traditional land management systems of local communities during the periods when Ethiopia was without a clearly identified central authority in the 'Era of the Princes' as far back as the seventeenth century (Tewolde 1989, in Tilahun *et al*. 1996). As a result of these changes, in most areas of the region, farmers were only able to control access to the land they farmed during the growing season. After the harvest, land and the natural resources associated with it – water, grazing land, trees, etc. – were freely available to all members of the community, without any of the controls previously used. That these controls existed is still evident in remnants such as the controlled access to grazing land by different categories of domestic animals, with priority being given to plough oxen, found in some parts. The frequent redistribution of cultivated land under the Dergue mostly eliminated the little motivation that had existed for land improvement or for protection of indigenous vegetation. Now all regions in Ethiopia are issuing their farmers with landholding certificates giving them leasehold rights for at least two generations. In Addis Ababa the leasehold right is for 99 years. The impact on the attitudes of farmers to investing in their land can be seen in many parts of the country in the form of small private plantations of trees, mostly *Eucalyptus*, but increasingly involving other species including indigenous ones with special economic importance. The Orthodox Church and Islam have, however, always taught respect for flora and fauna, with the result that churches and mosques still offer small areas of environmental protection that are often unique in the area, while in areas such as Awi Zone and Guassa in Ethiopia local communities continue to manage communal resources, a tradition which enables more sustainable use of the environment.

The concept of conservation of officially designated areas first emerged during the period of the Italian occupation in the 1930s. It has continued since that time, but has been implemented largely only half-heartedly and was until recently still viewed in terms that did not provide for the needs of local people and were never understood or fully accepted by them. It is therefore hardly surprising that substantial damage to national park infrastructure occurred in the period of instability preceding and subsequent to the change of government in Ethiopia in 1991. Present and future conservation policies in both countries should involve local communities more in decision-making and demonstrate tangible benefits to them in order to be accepted and effective.

The region is rich in biodiversity. The highest level of biodiversity is found in the Ogaden in south-eastern Ethiopia (Gilbert 1986, Tilahun *et al*. 1996); the Afro-alpine areas of mountains in the region are home to many endemic plant and animal species; the highland plateau is rich in crop plant diversity (Edwards 1991) with races of indigenous crops that have evolved over thousands of years, looked after by farmers using traditional knowledge of how crops can survive in harsh conditions. However, the future of biodiversity throughout the region is unsure. It is at risk from continuing population growth, which brings, among other things, increasing pressure on land for cultivation, wood for energy and construction, grasslands, wetlands and fallow land for grazing. In recent years it has also brought demands for food-aid from elsewhere and the obligatory relocation of populations of indigenous people within the country. Various aspects of these problems are discussed within this book, particularly in the sections concerned with vegetation, conservation and habitats.

THE HISTORICAL QUEST FOR BIRDS IN ETHIOPIA AND ERITREA

Caroline Ash

'The abyssins have many sorts of fowls both wild and tame, some of the former we are yet unacquainted with.'
Jeronimo Lobo (Gold 1985).

The area of what now constitutes the modern countries of Ethiopia and Eritrea encloses a rugged plateau averaging 2500m wedged between the Red Sea and the River Nile. It is split to the south by the Rift Valley and dissected to the west by the tributaries of the Nile. Until the boundaries of the modern states were defined at the end of the nineteenth century, the mountainous region north of the Rift Valley inhabited by Christians tended to be known as the empire of Abyssinia. To the south lay the highlands of Shewa and beyond lay the Muslim lands of the Somalis and Oromo. Over the centuries Abyssinia's borders have been fluid, but the precipitous mountains have always provided some form to the state (Marcus 1994), and attempts to gain access to the sea provided interactions with foreigners.

This part of eastern Africa has long held an almost mystical attraction for explorers, not only because of its unique human cultures and natural resources, but also for strategic reasons. The people who undertook these expeditions were usually men and comprised an assortment of adventurers, fugitives, traders, tourists, mercenaries, diplomats, colonists, a few with more scholarly inclinations, and a smattering of professional ornithologists. Regardless of the primary motive for an expedition, amassing a natural history collection to some elusive point of completeness became a goal in itself.

Apart from the past 20 years or so, the recorded history of bird observations in Ethiopia and Eritrea is primarily European, and extends from the early seventeenth century, through the 'Age of Discovery' to the claims of empire building, culminating in the volumes of live observations made by numerous amateur and professional expeditions in the twentieth century. The intention of this summary is to outline the procession of expeditions that contributed to knowledge of birds in the region within a sketch of broader context that is intended to help explain connections. The treatment is selective and there are omissions. Some of the expeditions have also been noted in *Birds of Somalia* (Ash & Miskell 1998), and much of the available literature has been cited in other chapters.

Lyons, unicorns and elephants

There is a continuum of interactions between the Horn of Africa and Europe that pre-dates the ancient Greeks, but it seems that not until the Portuguese arrived in the sixteenth century were any detailed European natural history records made. The most notable of these were by Jeronimo Lobo (1593–1678), who arrived at the Jesuit house known as 'Fremona', south-west of Massawa on the Red Sea in 1625 (Gold 1985). In search of Cristavão da Gama's remains, Lobo travelled extensively and eventfully in the northern highlands, inspecting the source of the Nile and reporting on the people, geography and natural history. He recorded few specific descriptions of birds, being more impressed by 'lyons', unicorns and stupendously huge elephants, but he did note at least two. The first Lobo explained 'has instead of a comb, a short horn upon its head, which is thick, and round, and open at the top. The *feitan favaz* or devil's horse looks like a man dress'd in feathers, it walks with abundance of majesty, till it finds itself persued, and then takes wing and flies away'. The second bird Lobo described is more recognisable, 'But amongst all these birds, there is none more remarkable than the *moroc,* or honey-bird which is furnished by nature with a particular instinct or faculty of discovering honey'. Back in Europe, Lobo developed a reputation as an explorer, corresponding with Henry Oldenburg, the secretary of the Royal Society in Britain, about the sources of the Nile, and died a famous man in 1678.

After the Jesuits left, there followed a period of quasi-isolation from Europe, broken only by a visit in 1699 from Charles Poncet, a French apothecary to treat the Emperor Iyasu I, but who left scant natural history observations. In 1771 James Bruce of Kinnaird (1730–1794) made his way to Gonder to discover the source of the Nile (Bruce 1790). Throughout his life, Bruce was embattled by personal loss and dispute. He disembarked at Massawa, noting the Barn Swallows and Northern House Martins, scaled the escarpment and travelled through Adwa and Axum to the Emperor Tekle Haimanot's court. Bruce's interests in Abyssinian avifauna were primarily biblical and he only made written records of a dozen or so recognisable species. He discriminated sufficiently among the birds to note the seasonal migration of the Black Kites, and recorded the raptors that followed the Emperor's frequent punitive expeditions as he struggled to retain power. On his return Bruce gave some bird specimens, including an Abyssinian Roller and an Abyssinian Ground Hornbill, to Buffon, one of the founders of systematic ornithology, who added them to the *cabinet du Roi* (Farber 1997). Bruce's account of his own journeys contains unacknowledged natural history drawings and paintings made by his companion, Luigi Balugani (1737–1770), who later died at Gonder. Balugani's exquisite illustrations of plants have now been published (Hulton *et al*. 1991). Eight new species were described from these illustrations, some of which are now in the Royal Collection at Windsor, UK, and at Yale. The Yale Center for British Art holds 422 Balugani drawings of flora, fauna and natural history subjects. Of these, two sketchbooks containing 62 drawings are dedicated to birds. Other items from Bruce's collections are in the Bodleian Library, Oxford, UK.

Collecting frenzy and museum rivalries

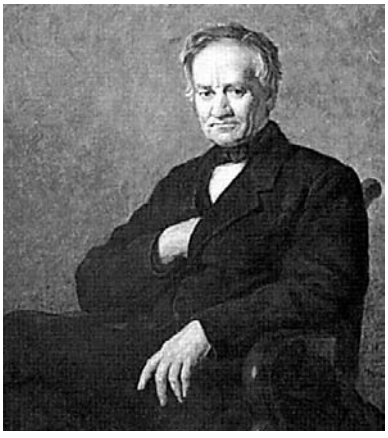
After the Napoleonic wars, global travel escalated, fuelled by the industrialisation of northern Europe. Collections helped to map the distribution of precious antiquities and natural resources, and museums supplied the information by which territory could be claimed and commerce conducted. As the requirements grew ever more stringent for quality of preservation, discovery of new species, notes on distribution, sexual variation as well as life histories, the established museums began to see advantages in employing discerning professional collectors for expeditions (Whitaker 1996).

Immediately after the British reclaimed Egypt from Napoleon, George Annesley, Viscount Valentia, attempted to survey the Red Sea in 1805 and make commercial connections with the Abyssinian hinterland. Valentia brought Henry Salt (1780–1827) with him as secretary

and artist (Manley & Ree 2001). Salt won considerable celebrity in England, and buoyed by this he sailed again for Abyssinia in the spring of 1809, bearing letters from George III. While waiting for permission to join the court at Gonder, Salt and his assistant Richard Stuart collected several new species of bird from the Red Sea, as well as making careful records of numerous parrots, sunbirds and thrushes on their ascent to the highlands. He returned to London in early May 1810, leaving behind Nathaniel Pearce and William Coffin, but taking 70 bird specimens and a bat. He was elected Fellow of the Linnean Society in London, which earned him the patronage of the mighty Sir Joseph Banks, and subsequently developed a career as a supplier of antiquities and exotic objects to museums; but his chaotic life precipitated an early death in penury.

Although the museum in Paris had become foremost in Europe for distributing government funding and training for young naturalists, the new University Museum of Berlin also sponsored extensive expeditions, including those of Christian Gottfried Ehrenberg (1795–1876) and his companion Friedrich Wilhelm Hemprich (1796–1825). Alexander von Humboldt recommended them to the Prussian Academy of Science for exploration in northern Africa. In 1820–1826 they embarked on a hazardous journey, during which three-quarters of their number died, including Hemprich. Apart from making massive collections of diatoms and plankton, they also wrote an account of birds (Jahn 1998). The Berlin museum received 114 boxes containing 46,000 plant and 34,000 animal specimens, plus seeds, rocks, fossils and mummies (Stresemann 1954).

Christian Gottfried Ehrenberg



Wilhelm P.E.S. Rüppell

The German state museums were noted rivals in their efforts to make the most comprehensive natural history collections. In competition with his Prussian rivals W.P.E.S. Rüppell (1794–1884), sponsored by the Senckenberg Museum in his home town of Frankfurt-am-Main, started another gruelling journey (Klausewitz 2002). By 1830 Rüppell had traversed Abyssinia and mapped Lake Tana. His voluminous collections made during the 13 years he spent in the country contained over 100 new species of birds, as well as the iconic and now endangered Ethiopian Wolf. In his book, *Travels in Abyssinia,* he listed 532 bird species occurring in the region.

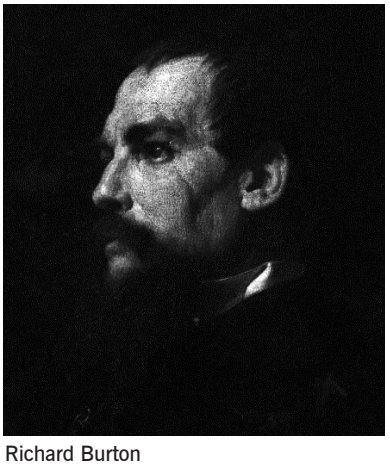
The south-western slopes of the highlands appear to have remained unknown to European naturalists until in 1838 Antoine Thompson d'Abbadie (1810–1897) and his brother Arnaud Michel d'Abbadie were sent by the French Academy of Sciences on a geographic and scientific expedition that was to last for 12 years (d'Abbadie 1868). The French wanted to establish themselves strategically in Africa to undermine British influence. Several overlapping expeditions involving at least 30 French nationals coordinated their activities with the brothers (Jaenen 2003), but of all of them the d'Abbadies travelled the most. As well as in Kefa and the Omo River valley in the south-west they comprehensively surveyed central and northern Abyssinia and amassed major natural history and ethnographic collections, which eventually went to the natural history museum in Paris and brought the d'Abbadies great acclaim in France.

Apart from anthropological observations, the Lefebvre, Petit and Quartin-Dillon expedition of 1839–1843 (Lefebvre 1863) made a bird collection, which was later worked on by Florent Prevost and Marc DesMurs at the Paris museum. Théophile Lefebvre (1811–1860) was a French naval officer who visited Tigray (Tegray) in the northern massif, and was asked by Dejazmatch Haile Mariam to request arms from the French government in return for Red Sea access at Anfilla (now Anfile). During 1840–1842, Pierre Victor Adolphe Ferret and Joseph Germain Galinier (1814–1888) were also travelling in northern Abyssinia and made a significant bird collection that included 15 new species (Ferret & Galinier 1847). The Frenchmen were based on the Eritrean border at Intetchaou near Adigrat, travelled in the highlands beyond Gonder to survey Lake Tana and the source of the Nile, and coordinated with the d'Abbadie brothers at Adwa.

Travelling incognito

Richard Burton (1821–1890) was the shadow behind the British scramble for Africa, and as well as his own travelogues left a paper trail of opinion in the *Proceedings of the Royal Geographical Society*. Burton travelled in East Africa with the mercurial John Hanning Speke (1827–1864), an obsessional hunter who made a huge personal wildlife collection including birds (Sclater 1864). After an initial trip to Somaliland, during which Burton was speared in the face, in 1855 he and Speke travelled in disguise to the holy city of Harar on the eastern borders of Abyssinia. After brief service in the Crimean War, Burton and Speke returned to exploration of the east African lakes, but in 1862 Speke contentiously claimed to have solved 'the question of the Nile', earning the abiding fury of Burton and nemesis at his own hand (Moorehead 1983a).

As European interest in Africa spread, an Austrian diplomat, Theodor von Heuglin (1824–1876), started his career in northern Africa before he was sent to Abyssinia in 1852 to negotiate a treaty with the Webé of Tigray. In all, he spent 12 years in the northern



Richard Burton

highlands, the Red Sea and Harar, occupied by his fascination with the antiquities, landscape and wildlife. He sent his bird specimens to Leipzig to the prodigious collector Pastor Christian Ludwig Brehm. Brehm's son Alfred had also made collecting expeditions on the western borders of Abyssinia during 1847–1852 (Brehm 1863). The Brehms' collection became highly peripatetic: it was first bought by Lord Rothschild in 1900 and added to the Tring Museum in Britain, but many of the Tring birds were sold in the 1930s to the American Museum of Natural History in New York, and then in the 1960s some of them were redistributed to Bonn (Mearns & Mearns 1998).

Theodor von Heuglin

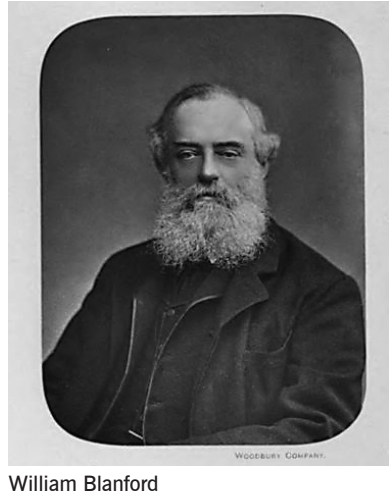
During 1861–1862 Heuglin returned to Abyssinia accompanied by Werner Munzinger, H. Schubert, T. Kinzelbach and Dr H. Steudner on an expedition searching for Eduard Vogel, a German explorer who had been missing since 1855. They travelled through Keren, Adwa and Axum, crossed the Tacazze River, and bypassed the Simien massif to reach Gonder. In May 1862 they left for the Nile tributaries en route to Khartoum, accumulating observations on the fauna and flora of the western slopes of the Abyssinian massif (Heuglin 1857–1877). In Khartoum, Heuglin met Samuel and Florence Baker, and the Dutch heiress and photographer Alexandrine Tinne. The Bakers were inspired to go hunting along the Abyssinian tributaries of the Nile for five years during the 1860s. Tinne joined Heuglin's party and together they travelled up the White Nile. Heuglin returned to Europe in 1864, went to the Arctic but returned to Abyssinia in 1875. Unfortunately he collapsed and died in Stuttgart before he could realise his plans to investigate the island of Socotra. During his productive life Heuglin also worked on Antinori's catalogue of 227 bird specimens collected between 1870 and 1871 from Bogos (now in Eritrea), as well as on Paul Wilhem von Württemberg's collections made when he was Pasha (governor) of Massawa during 1842–1844 (Baldamus 1857). Heuglin remained the authority on birds of the region for nearly a century, having recorded 948 species.

Samuel and Florence Baker

By the middle of the nineteenth century many European countries were playing out their rivalries along the Nile by employing an array of adventurers with uncertain allegiances. Carlo Piaggia (1830–1882) had a long career along the Nile and in Abyssinia, joining many of the major expeditions (Almagia 1932). He first arrived in Tunisia in 1851; five years later he was at Alexandria before travelling to Khartoum and spending two arduous years following the Nile. In 1861, when Samuel Baker was travelling upstream in an attempt to locate the lost and then presumed dead Speke, Piaggia had joined forces with the Perugian exile and ornithologist Orazio Antinori (1811–1882). Together they traced the Bahr-el-Ghazal. By 1865 Antinori and Piaggia reached the land of Niam Niam (the Omo river basin).

An extraordinary campaign

Emperor Tewodros only gained European attention when he imprisoned the British consul and other Europeans in the mountain fortress of Magdala. His action prompted Queen Victoria's government to send the veteran of the Indian Mutiny, Lt-General Lord Robert Napier, to the rescue in 1868. The ensuing expedition was planned with an extravagance designed not to fail (Moorehead 1983b). The campaign cost £9 million, and recruited 36,000 people, including naturalists and collectors, as well as 20,000 mules, several elephants, 280 ships and a railway. It consulted Baker and Burton and attracted the adventurer Henry Morton Stanley on his first African trip as a journalist for the *New York Herald* (McLynn 1989). Several experienced explorers were recruited: Major James Grant, the military adventurer Captain Speedy, Werner Munzinger, who could speak Amharic and Arabic, Wilfred Thesiger's grandfather and a miscellany of observers from various European governments. Frank James was the expedition artist.



William Blanford

William Blanford (1832–1905) was appointed chief naturalist; he had joined the geological survey of India in 1855, and later became celebrated for his editorship of *The Fauna of British India* (1888–1891). His main responsibility was to ensure water supplies, but he was passionately interested in snails. In January 1868 Blanford had crossed the coastal plain from the expedition's headquarters at Annesley Bay, Zoulla (Zula), south of Massawa via the hot springs of Komeylee, en route to Senafe in the highlands, while his colleague William Jesse remained behind. The snails were poor, but by March Blanford had also collected 200 specimens of birds and mammals, including the endemic Thick-billed Raven *Corvus crassirostris*. He communicated his findings from the Abyssinian expedition in a series of letters sent to the Asiatic Society, culminating in a travelogue illustrated by Johannes Gerardus Keulemans (Blanford 1870). By Good Friday, 11 April, the expedition had completed

its task: after a brief and violent engagement that defeated the battle-weary Abyssinian troops, Tewodros killed himself and the British withdrew rapidly with the crown jewels. The departing British assisted Ras Kassai to become Yohannes IV, King of Kings of Abyssinia. As the final cut was made to the Suez Canal in 1869, Menelik became King of Shewa, under condition that he send tributes to Yohannes.

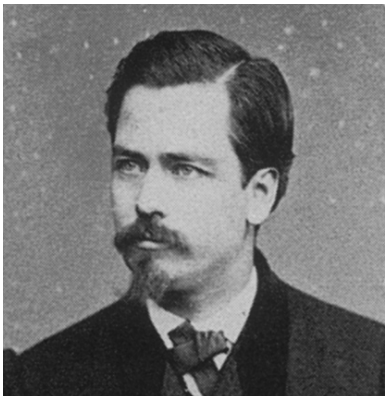
The opening of Suez meant a need for coaling stations on the Red Sea, which together with the advent of quinine magnified the volume of European traffic to Africa. On the Arabian side of the Red Sea the British had already claimed Aden, on the opposite shore the French developed Obock as their port, and an Italian shipping company had bought the port of Assab (Aseb) north of Obock. Menelik wanted sea access for commerce to supply his growing territorial ambitions and to control European encroachment. Implementing his ambitions, as well as his need to pay tribute to Yohannes, meant taxing his subjects heavily: his raiding parties were a constant hazard not only to the Shewans but also to European visitors.

Chiarissimi naturalisti

The new Italian state was keen to flex its unified muscle on the world stage, and under the auspices of the Genoa Museum in 1870–1871 the reinstated, and now Marquis, Antinori, with his companions the botanist Odoardo Beccari and Arturo Issel, was sent to Assab (Antinori & Salvadori 1873). Antinori stayed in Keren after his companions returned to Italy, and continued to work on his collection, comparing his records with those of the *chiarissimi naturalisti* Blandford and Jesse. In September–October 1871 he was in the Barka river valley, where he recorded large numbers of storks and ostriches, obtained specimens, and made notes on faunal distribution. Back in Massawa he resumed the cataloguing of Beccari and Issel's fishes and waited for Piaggia.

Orazio Antinori

By this time Massawa was in Egyptian hands and the Swiss Werner Munzinger (1832–1875) was governor (Pasha). In January 1872 the indomitable Piaggia, severely buffeted by circumstance, arrived with a beautiful collection of birds for Vienna. Seeing these the Pasha commissioned Piaggia to make another collection of animals and prospect for minerals (Piaggia 1875). In October 1872, Piaggia joined forces with I.M. Hildebrandt and headed off for Lake Tana. After a series of unfortunate events Piaggia finally found refuge in Yohannes' entourage. With his companion, Mabruk, the resourceful Piaggia took the opportunity to complete a survey of Lake Tana in a papyrus boat, make natural history collections and visit churches, even at last finding traces of gold in a mountain stream. After an absence of nine years, in 1875 the Italian travelled down the Atbara river and arrived in Khartoum. The great ornithologist Tommaso Salvadori took charge of Piaggia's collections, adding them to the vast Museum of Zoology at Turin.



Tommaso Salvadori

In 1876, the British Prime Minister, Disraeli, bought Khedive Ismail's shares in the Suez Canal to buy off his debts, and Britain and France embarked on a shaky partnership to 'manage' the Khedive's affairs (Pakenham 1998). Piaggia was among the first to take advantage of British interests in Egypt and joined Gordon's miscellaneous retinue in their attempt to map and annex the entire length of the Nile for Egypt.

Stimulated by a visit to Rome by King Menelik, the Italian Geographical Society despatched Antinori to the Shewan capital of Ankober to establish headquarters at the base of the escarpment at Let Marafeya. This became the hub for many subsequent Italian expeditions in the 1880s, including that of the famous explorer and collector Antonio Cecchi, who later became an administrator of Italian Somaliland (Cecchi 1886, Hess 1966).

After the Mahdists annihilated Hicks Pasha in 1883, General Gordon arrived in February 1884 to organise the evacuation but became besieged in Khartoum. To ensure a clear passage for the retreat, Rear Admiral Sir William Hewett went to Abyssinia in June 1884 and made a treaty with Yohannes ceding territorial claims in return. However, the British did not want the port at Massawa to be controlled by the Abyssinians nor the French; instead they let the Italians become the gatekeepers on the Red Sea (Pakenham 1998).

Barbets, bush-shrikes and boundaries

Menelik recruited several skilled Europeans to implement his modernisation plans, but his most significant appointment was the Swiss engineer Alfred Ilg (1854–1916). Ilg was the intermediary through whom Europeans gained access to the country, and with his support Menelik became adept at using foreigners to forge routes to the coast, establish boundaries, and sustain trade in armaments and slaves. For 20 years Ilg was ubiquitous, turning up to advise or chastise many expeditionaries; and among his many accomplishments he also managed to make collections of arthropods (Forel 1894).

The Egyptian city of Harar, perched on the southern highlands and overlooking the eastern coastal plains, became the hub for the French and Italian trade to Menelik's kingdom, as well as a stopping point for numerous expeditions. The renegade poet Arthur Rimbaud lived in Harar and Aden for eleven years as a trader (Nicholl 1997). He became friends with Jules Borelli, author of *Ethiopie meridionale*, was well acquainted with Alfred Ilg, and contributed an account of Constantin Sotiro's trip to the Ogaden in June–July 1883 to the *Comptes rendus* of the French Société de Géographie. Apart from these sparse reports, Rimbaud made no other recorded contributions to natural history except for pickling an Abyssinian Ground Hornbill's head and sending it home to his mother.

To the south and east the British were penetrating Somali territory and probing the southern boundaries of Shewa. In November 1884 Frank L. James and his brother set off with Percy Aylmer and Godfray Thrupp through north Somaliland to reach the Ogaden in January 1885 (James 1885). This expedition could not have set off at a worse time: it overlapped the Berlin conference of November 1884, convened to carve up European spheres of influence across Africa, as well as the Mahdi's siege of Khartoum – Gordon was beheaded on 26 January 1885. Telegrams from the British government fluttered after the explorers, ordering their return. Despite their many difficulties a major collection was made, including several new species of bird and a bizarre social mammal, the Naked Mole Rat. From this collection, the prolific ornithologist George E. Shelley identified 61 species of birds, of which seven were new to science, including barbets, starlings and bush-shrikes (Shelley 1888). At Harar the British team met the Austrian ethnologist Dr P. Viktor Paulitschke and the sportsman Dr von Hardegger. The Austrians travelled and collected in the Ogaden, subsequently making important contributions to the Museum für Völkerkunde in Vienna (Paulitschke 1889).

By this time, Italian colonial interests had become more assertive; they gained control of southern Somaliland and occupied Massawa, supplied arms to Menelik and explored the hinterland. To support General Wolseley's expedition to retake Khartoum, the young British diplomat Gerald Portal was sent on a secret and hazardous mission to Yohannes' court disguised as a hunting trip (Portal 1887) in a vain attempt to persuade the Emperor to cede back the parts of Bogos that Hewett had handed over. Yohannes was killed in 1889 during a Mahdist incursion. Menelik did not hesitate to claim the thrones of Abyssinia and Shewa, and urged his Italian allies to penetrate inland from Massawa and take the highland city of Asmara. On 2 May 1889, Menelik as Emperor of Ethiopia signed the treacherously translated treaty of Wichalé with Count Pietro Antonelli and sealed the fate of Eritrea as an Italian colony and Ethiopia as an Italian protectorate.

Last of the unexplored territory

In the final throes of the scramble for Africa, Lake Rudolf (now Turkana) acquired particular significance, as at the end of the nineteenth century this was the last 'unknown' fragment of the continent (Imperato 1998).

Prince Eugenio Ruspoli's and Captain Vittorio Bottego's ill-fated attempt to reach Lake Rudolph by travelling up the Juba river ended in Ruspoli's death 150 miles from his goal on 4 December 1893 during an elephant charge. He left his name in *Tauraco ruspolii*. The type specimen of this endemic species was found in the Prince's collection when it was returned to Italy, but the bird's locality remained a mystery until C.W. Benson observed the turacos in the 1940s. Hard on Ruspoli's heels, and complaining about the Prince's rash behaviour, came an American, Arthur Donaldson Smith, who was determined to fix the geographical position of Lake Rudolph (Smith 1897). Smith hired a professional taxidermist, Edward Dodson, to accompany him and his friend Fred Gillett.

Menelik's raiding parties constantly harried the expedition across Borana, but excited Smith's admiration: 'a braver, hardier, more energetic, though savage lot of men could not be found'. Smith was tough too: neither charging rhinos, Abyssinians, lightning, fever nor flooding rivers deterred him from methodically collecting and surveying until he reached Lake Abaya. By the end of May his party had reached Lake Stefanie (now Chew Bahir) and sighted Lake Rudolf on 14 July 1895. After a deviation north to Murle on the River Omo they crossed Marsabit and gained the coast at Lamu. Smith and his companions had collected 700 birds, among which Richard Bowdler Sharpe at the British Museum found 24 new species. Smith also accumulated specimens of 300 reptiles, 300 plants, more than 1000 butterflies, 3000 other insects, 200 mammals and some rocks. The British Museum received most of Smith's type specimens; the remainder went to the Academy of Natural Sciences in Philadelphia, USA. Smith was an accomplished cartographer, very aware of the value of his maps, and used them to negotiate influence with the Royal Geographic Society in London.

Claiming the heart of the continent

While Smith trekked to Lake Rudolf, tensions between Britain and France over Egypt were mounting. In 1895 Sir Edward Grey, the British Under Secretary of State for Foreign Affairs (and a dedicated ornithologist), declared the entire length of the Nile to be British territory, thereby provoking an expeditionary race that almost led to war between Britain and France. The focus was a small antislavery post, Fashoda (now Kodok), 100 km north of the confluence with the Sobat river. Menelik succeeded in trading access to the Nile among the European rivals to win guaranteed access to the coast (Lewis 1987).

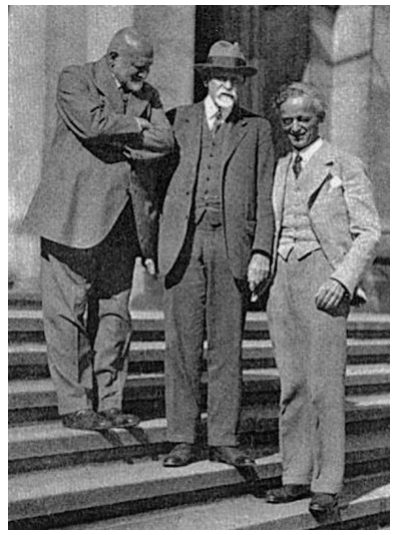
1896 was a pivotal year from many perspectives. Shelley started writing *The Birds of Africa*, a project that was to take him 16 years and fill five volumes (reviewed in Oberholser 1913). Shelley not only produced the massive work covering all African species, including all those in the Ethiopian region (Shelley 1896–1912), but he also wrote a monograph on the sunbirds (Shelley 1876–1880), and another on the birds of the Horn of Africa (Shelley 1888). This year the Italians ignominiously lost to the Ethiopians at the Battle of Adwa; an event that was to foreshadow future calamities but had the immediate effect of boosting Ethiopian confidence in dealing with Europeans. This year also saw Kitchener retake the Sudan and galvanise the British to secure access to the Nile.

While the British tried diplomatic manoeuvres the French decided in 1897 simply to march to the Nile. Aiming to meet at Fashoda, Captain Jean-Baptiste de Marchand (1863–1934) approached from the Congo, and Marquis Christian de Bonchamps (1860–1919), with his companion André Bonvalot, from Djibouti (Bonchamps 1898). To help install the newly appointed British representative John Harrington, the British gathered a group of impressively tall veterans from Napier's expedition including Swayne, the scholarly Herbert Weld Blundell, Reginald Wingate and a squad of Sikh soldiers, all led by the poet and diplomat Sir James Rennell Rodd (1858–1941) (Gleichen 1898).

Menelik ensured the French travelled only at his convenience. They endured appalling hardships, but apparently still made natural history collections, although it is not clear what happened to them. The result of Menelik's manipulations was that Bonchamps and March- and missed meeting at the Nile by two weeks. The French were outnumbered by Kitchener's forces and Marchand retreated ignominiously to Djibouti. The British had gained the advantage because they granted Menelik access to the port at Zeila (Pakenham 1998). Although the outward journey had not permitted Swayne the time, on the return he could do what he enjoyed most and said he made 'astronomical observations…; and every spare moment, while coming on slowly with the rearguard, was devoted to taking photographs, drawing, or collecting butterflies' (Swayne 1903).

Despite the circumstances Donaldson Smith tried hard to obtain funds from British institutions for another trip to Lake Rudolf. Denied money and access, he had to watch from afar: lending a medical hand in the Afghan wars and writing dispatches for the *New York Sun*. In 1898 Blundell was allowed to return to Ethiopia via Zeila, accompanied by Lord Lovat, the polar explorer and medical doctor Reginald Koettlitz (who was to travel with Captain Scott on the *Discovery* in 1902) , and the naturalist Mr Harwood. During a transect of 300 miles of Menelik's empire, Blundell made maps and Lord Lovat shot 523 birds of 303 species, as well as confirming several of Rüppell's type specimens (Blundell and Lovat 1899, Blundell 1900).

Early in 1899 Baron Carlo Freiherr von Erlanger (1872–1904) asked Oscar Rudolf Neumann (1867–1946), a companion on earlier travels in Kurdistan and Armenia, to join him on a trip to Somaliland and Ethiopia (Neumann 1902d). They ended up separating: Erlanger headed south-east to Sheik Hussein, while Neumann went south-west to Lake Stefanie and the Omo River. The drought conditions were so severe that Neumann recorded children being sold in markets alongside livestock and grain. On reaching the slow-moving, crocodile-infested Pibor River, the combined effects of the drought, desertion of his porters, rinderpest and failing food supplies persuaded Neumann to jettison everything inessential into the river. He reported 'the only part of my belongings which I contrived to bring safely home being my collections, photographs, diary, and route books', including 2000 fossils, 700 rock specimens, a new species of hartebeest and several hundred plants – an astonishing burden for a desperate man. He was literally saved by the bell: at the moment Neumann was burying his ivory in a hole in the riverbank Slatin Pasha turned up in a steam boat and rescued the expedition.



Oscar Neumann (left) with Ernst Hartert (centre) and Erwin Stresemann (right)

Erlanger's birds obtained on his trip formed one of the most important collections of the Senckenberg Museum at Frankfurt (Hilgert 1908, Naumburg 1931). Neumann's went to the Museum at Tring, where he worked briefly under Rothschild's patronage. Financial distress made Neumann return to Berlin, where he worked as a stockbroker until the Nazi regime forced him to flee to Cuba. From there he migrated to the Field Museum in Chicago (Stresemann 1947).

Donaldson Smith finally succeeded in gaining support from the Prince of Baroda, who wanted specimens for his personal museum (Sharpe 1901). Eventually, the Prince donated 103 bird specimens to the British Museum. Smith reached Lake Rudolf on 10 December 1899, followed by J.J. Harrison's and Percy Powell-Cotton's (1866–1940) hunting expedition (Powell-Cotton 1902). One purpose was to hoist a flag at Murle between Menelik's empire and British East Africa, but they also collected 300 specimens of 150 bird species (Ogilvie-Grant 1900), a new species of bat and an albino topi. Powell-Cotton kept a museum for his trophies, where he pioneered the use of diorama. The museum is still open at the family home in England, Quex House, Birchington, Kent. In 1901 the Royal Geographical Society awarded the persistent Donaldson Smith the Patron's medal for 'For memorable journey across the unknown parts of Lake Rudolf and the Omo' [*sic*].

Baron Carlo Freiherr von Erlanger

By the turn of the nineteenth century American industrialists with astonishing fortunes could afford to indulge their frontier spirit independently of European territorial concerns. In 1901 Oscar Terry Crosby, who had founded the Potomac Power Company, crossed Ethiopia. There seems to be a collection in the Smithsonian Institution in Washington D.C, USA, and his papers are lodged in the National Library of Congress (Krusten & Kerwin 2005). After the First World War, Crosby joined the US Treasury Department with particular interest in war reparations, wrote prolifically and resumed travels across Africa in the 1920s.

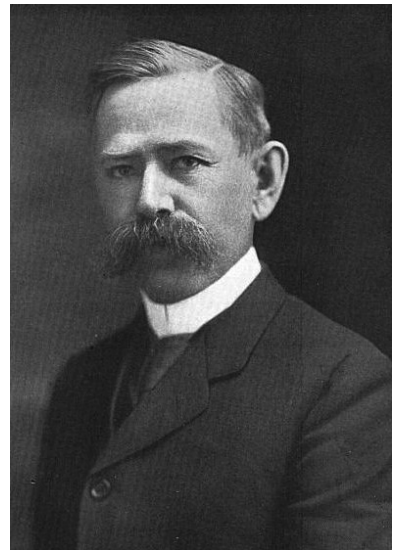
Surveying the Abbai

By 1902 Menelik renounced his claims on the Upper Nile as the British established the Uganda protectorate and Kenya colony. In September 1905, Sir Edward Grey, the British Foreign Secretary, was still anxious about control of the Nile and wanted it surveyed. William Northrupp MacMillan and his determined wife Lucie failed spectacularly in their attempts to navigate the Blue Nile (Abbai). MacMillan, a Scottish-born American industrialist and sportsman, had three steel boats built in sections that were reconstructed at the confluence with the Muger River. At the first cataract, one boat capsized, the other sank, and the expedition was aborted (Jessen 1906). Their political influence apparently undiminished, the MacMillans subsequently settled in British East Africa, hosting Roosevelt and Churchill on hunting

trips. MacMillan persuaded his friend Burchart Jessen to try again in 1905. Jessen travelled some 200 miles along the banks of the Abbai from the Sudan frontier accompanied by Photious C. Zaphiro (1879–1933), who worked as an interpreter attached to the British Legation in Addis Ababa, and was also a collector on several expeditions (e.g. Ogilvie-Grant 1907b, 1913). Zaphiro is buried in the graveyard at the British Embassy in Addis Ababa.

The Rothschild family became very interested in the Ethiopian Beta Israel communities at this time, because of their involvement in establishing a Jewish homeland. In 1904–1905, Maurice de Rothschild travelled with the collector C.F. Camburn, other scientists and two taxidermists from Paris to Djibouti and then to the highlands. The results of this expedition are dispersed in the literature: some of the non-avian specimens are in the museum in Paris and the birds went to Walter Rothschild's museum at Tring (LeCroy pers. comm.). Oscar Neumann worked on part of the collection, but it was never reported on in full. The insects and reptiles are documented in specialist journals. The Tring birds were later sold to the American Museum of Natural History (AMNH) in New York. Records from the AMNH also disclose its possession of at least 1400 specimens dated 1914–1915 and 1919 originating from the Rothschild collection at Tring, with Ethiopian localities labelled in Hungarian by Odon Kovacs. There is no other documentation for these birds and the circumstances of their acquisition are mysterious.

Wealthy Americans with a zeal for collecting continued to visit Ethiopia to seek trade and adventure. Childs Frick (1883–1965), the son of the Pittsburgh steel industrialist and art collector Henry Clay Frick, travelled to Ethiopia in 1911–1912 for Harvard's Museum of Comparative Zoology. Edgar Mearns, Teddy Roosevelt's companion on an African hunting trip in 1909, was the ornithologist. The expedition met in Djibouti, took the French railway to Dire Dawa and followed the Rift Valley south-west, stopping to collect intensively south of Lake Abaya before heading for the railway at Nairobi. Mearns was diabetic and suffered intensely on this trip; unfortunately he died in 1916 before he was able to complete his report on the astonishing collection constituting more than 5000 birds, nests and eggs now lodged in the Smithsonian Institution in Washington DC. Nevertheless, before his death he managed to name 88 species and subspecies (Friedmann 1930b).


Edgar Mearns

In 1913 Menelik died of a stroke, his consort Zawditu became Empress in 1916, and her cousin Ras Tefari asserted his authority as Regent (Marcus 1994). Subsequently, Egypt freed itself from the British in 1922, although they retained Sudan. The British pressed for a complete survey of the Abbai because of its significance to the irrigation schemes in the Sudan, and partly in response to France re-opening the arms trade to Ethiopia through Djibouti. A mission was sent to Lake Tana to investigate the prospects for a dam to regulate flow (Grabham & Black 1925), a project that was eventually turned over to American interests. R.E. Cheesman (1878–1962) was designated British Consul based at Lake Tana during 1925–1934, and part of his job was to survey 500 miles of the upper reaches of the Abbai. Funded by the Natural History Museum in London and Lord Rothschild, Cheesman collected 2000 bird skins and travelled over 5000 miles (Cheesman 1928). He was given the Gill Memorial Award by the Royal Geographical Society.

As Ethiopia turned away from its uncomfortable relations with Europe, the Regent, Ras Tafari, made contact with India and the USA, and increasing numbers of American visitors made their way to the country. Between 1926 and 1927 the celebrated American wildlife artist Louis Agassiz Fuertes and his companion Dr Wilfred Osgood, sponsored by the Field Museum and the *Chicago Daily News*, crossed Ethiopia from the Bale Mountains to Lake Tana and the Simien Mountains. Fuertes' series of colour plates changed the style and standard of wildlife painting; sadly this enthusiastic and talented man died only months after returning from Ethiopia (Fuertes & Osgood 1936). The Field Museum in Chicago holds many of Fuertes' beautiful illustrations of birds.

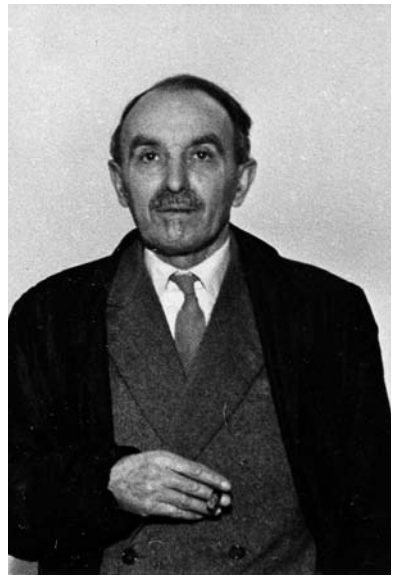
Baron Raimondo Franchetti, the headstrong scion of an aristocratic family who became known as *il Lawrence Italiano*, brought his interest in zoology to prospect for specimens in Ethiopia. Together with his friend Amedeo, Duke of Aosta, in 1921 they travelled across southern Ethiopia, and during 1928–1929 Franchetti crossed the Danakil from Gojjam to Eritrea to fill in another blank space on the Italian map of Africa. For his services he won an honorary membership of the Società Geografica Italiana. The majority of his collections were kept first at his property near Treviso and then donated to Museo Civico di Reggio Emilia (Ghigi 1931, Mondadori 1935).

Brief conquest

1930 saw the death of Empress Zawditu, the exile of Iyasu, and the ascendancy of the regent Ras Tefari to the Ethiopian throne as Haile Selassie. A spectacular ceremony was attended by a glittering selection of foreign envoys, journalists and guests, including the Thesigers and Evelyn Waugh. Wilfred P. Thesiger (1910–2003) was born at the British Embassy in Addis Ababa, and cut his expeditionary teeth exploring the Danakil in 1933–1934 (Thesiger 1998). He became renowned for his travelogues on the Arabian Empty Quarter, the marshes of Iraq and East Africa. Although his father taught Thesiger about birds, he was not very interested in them but did make one notable contribution to *Ibis* (Thesiger & Meynell 1935a). The Pitt Rivers Museum in Oxford holds a large collection of his photographs. While Thesiger was crossing the Danakil, Dean Hobbs Blanchard, a wealthy Californian, also travelled to the Awash River before veering south-west, collecting en route to augment his personal museum at Santa Barbara. Blanchard subsequently wrote extensively about his bird collection, annotating it with comments about parasites and migration (Blanchard 1969).

During the 1930s Haile Selassie consolidated his empire and promoted a tenuous modern infrastructure. In 1935, thwarted Italian colonial aspirations reached a head as Mussolini came to power. Ethiopia was invaded and the monarchy exiled to Britain (Marcus 1994). The Italians maintained an uncertain grip, particularly in remote rural areas, and avenged insurgency with violent repression. Ornithology, however, thrived. Augusto Toschi made several important bird collections from Lake Tana, Kefa, the Omo river area, Ogaden and western

Somaliland (Toschi 1959). Marchese Saverio Patrizi Naro Montoro (1902–1957) had already explored the Congo basin, and was a signatory of the 1933 London convention for the preservation of fauna and flora, which was instrumental in the establishment of national parks and reserves throughout Africa. He made large collections from the Rift Valley, the Didessa valley and the Juba river basin (Patrizi 1940a,b), which were distributed to the museums at Rome and Genoa (Ash & Miskell 1998). During 1940–1941 Toschi tried to consolidate all the specimens collected by Italian expeditions in the Laboratorio di Zoologia in Addis Ababa (Toschi 1959). Meanwhile, Edgardo Moltoni and Giuseppe Gnecchi Ruscone, based in Milan, compiled and succeeded in publishing four volumes on the birds of Italian Africa illustrated with over 150 illustrations by G. Galleli (Moltoni & Ruscone 1940–1944). It remained incomplete, as the Museum at Milan was burnt down during the European war.



Edgardo Moltoni

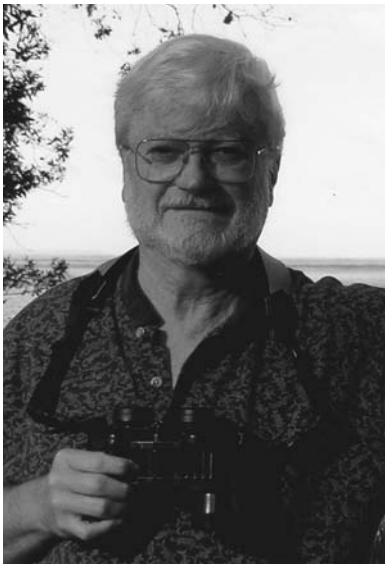
The last emperor

In January 1941 Haile Selassie with his patriots and a British force took advantage of the gaps in Italian control to retake Ethiopia. The demoralised Italians retreated to a few forts. Part of the natural history collections made by the Italians in the Bale Mountains seems to have been destroyed by Ethiopian militia, another part was plundered by British troops and some specimens were sent to the Coryndon Museum in Nairobi (Toschi 1959).

In May 1941 Haile Selassie was restored as Emperor but the country remained under Sir Philip Mitchell's British military administration for a further eight months while the remaining Italians in the Didessa valley were removed. As prisoners of war in British East Africa, Giulio Tartaglia worked on Toschi's collection at the Coryndon Museum while Toschi worked for Louis Leakey at Olduvai Gorge. Many of the Italians' specimens were sent to the British Museum at Tring, possibly after selection by Cheesman and R. Whalley. In 1955, Tartaglia seems to have restored some examples from the collection to Toschi in Bologna, and others were returned to Addis Ababa (Toschi 1959). After the war, a collaboration developed between Patrizi and Horatio M. Woodman, an American keen on hunting, who made many observations on arrival and departure dates of migrant waterfowl and of (mostly Great) Snipe (e.g. Woodman 1944c). Woodman hunted around Addis Ababa and shared a taxidermist with Patrizi.

Between June 1941 and March 1942 Mitchell sent Constantine W. Benson (1909 –1982) to rout the Italians from their fort at Mega. In his obituary Stuart Keith (1985) wrote that, 'It is said that his collecting gun was fired so often that the Italians refrained from attacking what they considered must be a large force.' From Mega, Benson made extensive patrols along the border with British East Africa, during which he made a large collection of birds, later written up in *Ibis*. After a return trip in 1946 Benson retired from the colonial service and in 1965 started work on the bird collections at the Cambridge University Museum of Zoology. In a similar role K.D. (Ken) Smith worked for the British administration of the UN Protectorate in Eritrea between 1944 and 1950, and published 21 papers from his observations and collections, including the excellent *Checklist of the Birds of Eritrea* (Smith 1957).

Haile Selassie consolidated his claims to the region as the British withdrew, keen to avoid annexation into British East Africa. After the war, a few years of relative peace and prosperity brought increasing numbers of foreign visitors to Ethiopia. The first class of students graduated from the University in Addis Ababa in 1954, and the science faculty grew in strength. By 1966 the Ethiopian Natural History and Wildlife Society was established.



Emil Urban

Despite US support, the country gradually became one of the poorest in Africa and the regime vulnerable, until finally in 1974 famine fuelled a creeping Marxist–Leninist revolution led by Mengistu Haile-Mariam that culminated in Haile Selassie's death in August 1974 (Marcus 1994). In 1991 an insurrection in Eritrea marched on Addis Ababa and established a western-oriented government led by Meles Zenawi. In 1993 Eritrea became independent; however, the borders of Ethiopia continue to be bloodily disputed by the Eritreans, Tigrayans and Somalis, and famine threatens repeatedly.

In spite of periodic turmoil, birds were watched and studied. Emil Urban, a professor at the university in Addis Ababa, co-authored a checklist of the birds with Leslie Brown (Urban & Brown 1971). Chris Hillman worked extensively in the Bale Mountains National Park (Hillman 1990). Stephanie Tyler became very familiar with the birds of Tigray and Eritrea when she and her family were held captive by guerillas in 1976. Melvin Bolton with C. Zewdie worked on a list of birds in the Nechisar National Park (Safford 1993). The taxidermist Svante Pohlstrand was an important pivot for collectors, and later his son, Håkan Pohlstrand, organised bird tours in the country with Kidane Biyadgo. John Ash had a particular interest in migrants, and travelled widely during his eight years in Ethiopia. His extensive observations on the distribution of birds in the region led directly to the development of the bird-mapping project, and to this atlas (and also to the publication of *Birds of Somalia* in 1998). John Atkins at Addis Ababa University coordinated record-keeping from many visiting ornithologists. Mike Jaeger worked on quelea control. In the late 1980s and early 1990s Tesfaye Hundessa and Yilma Dellelegn Abebe of the Ethiopian Wildlife Conservation Organisation undertook valuable surveys of the status of some Ethiopian bird species

and surveyed several lesser known areas. In the early 1990s the Ethiopian Wildlife and Natural History Society formed a partnership with BirdLife International to inventory Important Bird Areas. Sue Edwards, Solomon Tilahun and Tewolde Berhan Egzhiaber subsequently edited an account of these (Tilahun *et al*. 1996). Since the mid-1990s Mengistu Wondafrash has taken the reins for Ethiopian bird conservation, coordinating with BirdLife International, the Royal Society for the Protection of Birds and other organisations to find ways of protecting key sites for endangered species in the country. Mengistu Wondafrash, Yilma Dellelegn, Mihret Ewnetu, Anteneh Shimelis and others have also been running annual waterbird surveys for the International Wetlands Research Bureau. In Eritrea, Dawit Semere, Giuseppe De Marchi, Giorgio Chiozzi and colleagues carried out important research on breeding seabird populations on Red Sea islands between 2001 and 2007.

The geographical region encompassed by Ethiopia and Eritrea has constantly been subject to human upheaval, drought and famine. Its fauna and flora are unique and extremely vulnerable, and have attracted fascination for centuries. Much has been lost, but much has been learnt over the centuries of acquisition. As the world enters an era of accelerating environmental change it is important to bring the accumulation of stored knowledge of birds to sentinel the areas of high biodiversity that sustain the delicate landscapes of these countries.

TOPOGRAPHIC REGIONS AND HYDROGRAPHY IN ERITREA AND ETHIOPIA

Ethiopia and Eritrea are characterised by great topographical diversity, particularly altitudinal variation, ranging from 110m below sea-level in the Dallol Depression to 4620m in the Simien Mountains. This has created two broad climatic regions, the cool highlands and the hot lowlands. The region also contains more land above 2000m than in any other African country, with two main masses of high land, the western and northern highlands and the south-eastern highlands, separated by the Rift Valley. The following account of the topography and hydrography of the region is based on Westphal (1975), Last (1965), Ethiopian Mapping Authority (1988) and Tilahun *et al.* (1996). Logan (1946) and Yalden (1983) have also been referred to.

Topographic regions

There is some disagreement in the literature on the names of the main topographic regions. For our purposes we identify the following:

The Western Highlands (lying to the west of the Rift Valley and the Danakil or Afar Desert)
The South-eastern Highlands (south and east of the Rift Valley)
The Western Lowlands (bordering Sudan and extending south to the Omo valley)
The South-eastern Lowlands (of the Ogaden up to the border with Somalia)
The Southern Lowlands (extending across to the lower Omo valley)
The Rift Valley
The North-eastern Lowland Desert (desert and semi-desert lands of the Danakil, south and east to the Awash river)
The Red Sea coast and islands

These features are illustrated in Figure 8 and are described below.

1. The Western Highlands

The Western Highlands extend from Eritrea in the north to Kenya in the south and are considered here to include all land above 1500m, west and north of the Rift Valley and the Danakil Desert, and east of the Western Lowlands. Lowlands associated with the major rivers (e.g. Abay, Tacazze, Omo) are better considered for ornithological purposes as part of the Western Lowlands. The highest point is Ras Deshen, which at 4620m is the highest mountain in Ethiopia, in the Simien Mountains on the south side of the Tacazze river gorge.

The eastern escarpment runs more or less north to south at an altitude of 2100–2400m. In the north it is characterised by high, rugged mountains that tower over the lowlands of Eritrea, the Danakil and the Rift Valley below, while in the south, nearer to the Kenya border, the average elevation is lower, at about 1500m. The central area of the eastern escarpment is broken by the Awash valley. The western escarpment is less well defined, and is interrupted by rivers, as the land falls gently towards the west (Westphal 1975).

The plateau itself is a high tableland at an elevation of 1500–2000m, rising especially in the north to over 4000m, and dissected by steep-sided, deep valleys. Northern and southern parts of the plateau are separated by the impressive Abay (Blue Nile) river gorge, which in some places has cut down to nearly 2000m below the level of the adjacent plateau (Last 1965). Particularly in the northern and central parts of the region, erosion has created isolated flat-topped, steep-sided tables known as 'ambas' (Logan 1946).

2. The South-eastern Highlands

This refers to the highland plateau above 1500m east of the Rift Valley in Ethiopia, which creates an arc from the Kenya border to northern Somalia. It includes the Bale Mountains, the Arussi Highlands and the Chercher Mountains. Between 4° and 6°N the southern part of the plateau forms a section of the eastern wall of the Rift Valley at 1500–1800m. From 6°N the escarpment rises towards its highest area in the Chilalo Massif in the Arussi Highlands at 3000–4200m, with the highest point at Mount Kaka (4200m). As the escarpment curves eastwards, the elevation decreases steadily, falling to 1800m near Jijiga. The western face of the escarpment has heights ranging between 600 and 1200m above the surrounding area.

The main south-eastern highlands have been eroded into a narrow chain of smaller mountain groups (the Harar, Ahmar, Chercher, Gugu and Chilalo Massifs, and the mountains of Sidamo) by river systems draining towards the south-east into the Wabe Shabeelle. From the escarpment the land slopes gently south-eastwards towards the Indian Ocean. Erosion here has resulted in a series of narrow plateaus running south-east, separated by the valleys of the Dawa, Genale, Weyb (Webi Gestro) and Wabe Shabeelle rivers. The main rivers have cut deep gorges into the plateaus, the deepest and most dramatic of which is that created by the Wabe Shabeelle river.

The Bale Mountains, south of the upper Wabe Shabeelle river, form the largest area of very high land in the region, most of it being above 3000m, with several peaks, of which Mount Batu (4307m) and Tullu Deemtu (4377m) are the highest. An extensive, isolated highland region, it is separated from the main chain of the south-eastern highlands by the Wabe Shabeelle and the Genale rivers.

3. The Western Lowlands

The Western Lowlands are the plains bordering Sudan to the west of the Western Highlands, extending from northern Eritrea south to the lower Omo valley. The lowlands of the Abay and Tacazze rivers and their tributaries form part of this topographic region, where they penetrate into the Western Highland plateau. In Eritrea, between the Barka and Gash-Setit rivers, erosion has created wide lowland plains, while further south, between the Setit and the Abay, the plains are narrow and separated by long spurs of highland. In the south-western part of Ethiopia, the Baro–Akobo plains are structurally part of the Western Lowlands, while the Omo basin is part of the Rift Valley structure.

4. South-eastern Lowlands

This region includes the Harar and Ogaden plateaus, which slope gently away from the South-eastern Highlands escarpment towards the Indian Ocean. Erosion here has resulted in a series of narrow plateaus running south and south-east separated by river valleys. The main

rivers have cut deep gorges into the plateaus, which are particularly dramatic where they cut through limestone beds. A notable feature is the long cave system of the Weyb river, starting at Sof Omar. The Harar plateau lies north-east of the Wabe Shabeelle at altitudes between 1500m and approximately 1000m, slopes gently south, and is drained by the Erer, Fafen and other rivers. South of this, at altitudes between 1000m and 500m, lies the Ogaden plateau, a very dry area with many wadis that also drain into the Wabe Shabeelle. This and the Southern Lowlands are known for their rich biodiversity, resulting from the high diversity in the topography and geology forming ecologically distinct 'islands' in these areas.

5. The Southern Lowlands

This region includes land below 1500m to the west of the Wabe Shabeelle. Thus it refers to Sidamo and parts of southern Bale below 1500m. The Sidamo–Borana plateau has an elevation above 1000m sloping gently to the south. Erosion here has resulted in a series of narrow plateaus running south-east, separated by the valleys of the Dawa, Genale and Weyb rivers. The Southern Lowlands also include the lower Omo valley.

6. The Rift Valley

The Ethiopian–Eritrean region is bisected by the Rift Valley, which runs approximately north to south, and is enclosed east and west by the escarpments of the Eastern and Western Highlands. The narrowest part of the Rift Valley area, from approximately 5° to 8°N, has a width of 40–60km and contains a number of ornithologically important lakes, including Zwai, Langano, Abiata, Shalla, Awassa, Abaya and Chamo, and slopes gradually southwards from approximately 1600m at Lake Zwai to about 600m in the Chew Bahir area on the border with Kenya. The floor of this part of the Rift Valley is generally from 600 to 900m below the highest peaks of the escarpment which forms its walls. North of Lake Zwai the western wall of the Rift Valley turns due north, creating a wide plain between the escarpment and the Red Sea coast, until in Eritrea, north of Massawa, the foothills of the escarpment run parallel to the coast. The eastern wall of the Rift Valley turns to the north-east, and in this area the Rift Valley opens out into the Awash valley, the Afar Plains and Danakil Desert.

7. The North-eastern Lowlands

This region comprises the north-eastern lowland desert and semi-desert lands of the Danakil Desert and Afar Plains south to the Awash river and comprises sand and lava plains, which slope north-east, with altitudes in parts as low as 110m b.s.l. To the east of this area lie the Danakil Alps, a broken range of volcanic mountains parallel to the Red Sea coast.

8. The Red Sea coast and islands

This area includes the Red Sea coastline of Eritrea, the adjacent volcanic and rock desert hills and the many offshore islands, including Dahlak Islands, the islands of Howakil Bay and the Assab Islands.

Figure 1. A simplified map of the Dahlak Islands (showing those referred to in the text).

Coral beach and coastal vegetation, Dahlak Islands, Eritrea (Jason Anderson).

Hydrography

The general pattern of drainage in the region is the result of uplifting during the Tertiary period. The dome shape created by the uplifting would have drained north, south, east and west from the centre. However, the dome cracked and a rift valley was created, leaving the western highlands and eastern highlands on either side. The general slope of the western highlands is towards Sudan on the west and Kenya to the south, so drainage is north-westward and south, while the slope of the eastern highlands is towards the east and south-east, so drainage is in that direction (Last 1965). Even so, these highlands can be correctly referred to as the 'water tower' of the Horn of Africa. Interestingly, Addis Ababa is almost central in Ethiopia and central to the north–south watershed. Rain falling on the back of Entoto drains into the Muger and hence to the Abay, while rain falling on Addis Ababa drains south into the Awash. The Entoto ridge continues west and makes the divide between the Gilgil–Omo drainage south and the Guder, Fincha'a, Didessa and Dabus flowing north (S. Edwards, pers. comm.). River valleys are important corridor areas for birds; thus, for example, species typical of the western lowlands, but not the highlands, are found as far up the Abay system as the Jemmu river.

The principal river systems, all flowing from the highlands, are: the Tacazze–Setit–Angareb system, the Abay (Blue Nile) system and the Baro–Gilo–Akobo system to the west and north, the Awash to the east, the Wabe Shabeelle to the south-east, the Genale–Dawa–Weyb system and the Omo–Gibé system to the south. These are illustrated in Figure 14. In order of total annual volume, the major rivers rank as follows (Last 1965): 1. Abay, 2. Tacazze–Setit–Angareb, 3. Baro–Akobo–Gilo, 4. Omo, 5. Wabe Shabeelle, 6. Genale–Weyb–Dawa, 7. Awash, 8. Mareb–Gash, 9. Barka, 10. Sagan. The westward drainage of the first three river systems into the Nile basin constitutes nearly half the total volume of water drained from the country and provides over 80% of the water in the River Nile. However, the flow of water in all the region's rivers fluctuates considerably, being determined by the uneven annual distribution of rainfall (Last 1965).

In the Western Highlands, the plateaus to the north of Lake Tana are drained westwards by the Tacazze–Setit, which flows as the Tacazze in a deep gorge round the Simien Massif. Together with the Angareb and Atbara rivers, the Tacazze–Setit forms the headwaters of the Atbara drainage system. Further north in Eritrea, the Western Highland plateau is drained to the west by the Mareb–Gash, whose seasonal floodwaters are lost in the desert, and by the Barka and Anseba rivers. Apart from the Tacazze–Setit, the other rivers of Eritrea are all seasonal.

The central plateau of the Western Highlands in Ethiopia is drained south and west by the Abay (Blue Nile) river and its tributaries, which have carved deep and spectacular gorges, in places 1000–2000m below the general level of the surrounding plateau. Much of the water in the Abay comes from its left bank tributaries, particularly the Jemmu, Guder and Muger in the mid-Abay area, and the Didessa and Dabus in the high-rainfall region of western Ethiopia. The south-western highlands are also drained by the Baro–Gilo–Akobo system, which form the headwaters of the Sobat, and by the Omo–Gibe system. The south-western part of the Western Highlands is characterised by mature, broad river valleys, contrasting with the deep gorges of the northern plateaus.

The Omo, the only river of any significance to the west of the Rift Valley which is not part of the Nile system, and known in its upper course as the Gibé, drains into Lake Turkana. The Sagan flows into Chew Bahir.

Along the eastern edge of the Western Highlands a major watershed separates drainage westwards from drainage eastwards into the Red Sea and the Rift Valley. In Eritrea a number of small rivers, including the Felket, drain eastwards, but their seasonal floodwaters reach the Red Sea only in the rainy season. A number of small streams north of Dessie flow into the Kobar Sink in the Danakil Desert. The largest eastward-flowing river, the Awash, rises in the highlands west of Addis Ababa and drains into the Rift Valley before disappearing into the sands in Lake Abbé in the southern Danakil on the border with Djibouti.

The Eastern Highlands slope generally south-eastward so drainage is towards the Indian Ocean. A watershed separates drainage eastwards from drainage westwards into the Rift Valley. The eastern part of the South-eastern Highlands is drained by the Wabe Shabeelle and the Fafen and their tributaries. The south-western part, the mountains of Sidamo and Bale, is drained by the Weyb, Genale and Dawa rivers, which join together at Dolo to become the Juba. The seasonal streams of south-west Borana drain south into an area west of the Juba drainage system and east of Chew Bahir. The Rift Valley and the Afar Lowlands drain into a number of basins of inland drainage, the largest being the Awash basin.

Some lakes, for example Tana, Abaya and Chamo, have an important role in storing water which then feeds into rivers (Lake Tana drains into the Abay, Lake Abaya drains into Lake Chamo through the Kulfo river, and Chamo is the origin of the Sagan river) but most, especially several of the Rift Valley lakes, are closed basins with no rivers flowing from them.

THE GEOLOGY AND SOILS OF ETHIOPIA AND ERITREA

Geoffrey Last

All aspects of the natural and human environment of Ethiopia and Eritrea are characterised by their complexity and diversity. Contained within the borders of these two countries is the largest area of very high land on the continent of Africa and also the Kobar Sink in the Afar Plains, marking the lowest point on the continent at 110m below sea-level. The processes stretching over the long geological history from the Lower Precambrian formations of the earliest continents to very recent volcanic activity and alluvial deposits, and the dynamics of metamorphism, erosion and deposition, have created a geological map of great diversity. This complex pattern has had its impact on soil types and drainage patterns and has produced a wide range of environmental conditions for plant and animal life. The topography also contributes to variations in microclimates, with their diverse effects on all forms of life. These geological and topographical diversities and their related process of soil formation have influenced man's occupation and use of the land, his modification of natural vegetation and his interaction with wildlife.

The significance of soils and geology for birds

Soils and geology help to determine the distribution and evolution of many species of birds. Vegetation is dependent on and modified by soils, which themselves are dependent on the underlying geology. Thus environmental conditions and available food sources are determined at least partly by these factors. Some species, especially larks, have even evolved to match the dominant shade of the soil in their preferred habitat. Thus the Collared Bushlark has evolved in such a way as to match the red Haud soils found in the Ogaden. The White-tailed Bushlark has evolved to match the dark vertisols (Black Cotton Soils) of the south Ethiopian plains. The race *daaroodensis* of Blanford's Short-toed Lark has evolved to match the pale sandy soils of the short-grass open plains east of Jijiga. Similarly, races of the Desert Lark have taken on the colours of open, sparsely vegetated desert soils.

Geology

The following is a brief account of the geological history of Ethiopia and Eritrea (see Figure 10). Ethiopia has its foundations on the pre-Cambrian shield of Africa with a range of crystalline rocks. The original igneous and sedimentary rocks are interbedded with schists and gneisses and subsequent igneous intrusions in what is known as the Basement Complex. In the following Mesozoic era, the sinking of the landscape in north-east Africa and the resultant marine transgressions resulted in the deposition of early sandstones (Adigrat Sandstone) and limestones (Antalo Limestone). Then as the seas regressed there were younger deposits of sandstones and limestones, particularly in the eastern and south-eastern regions. At the end of the Cretaceous period only the Ogaden remained below sea-level.

Following this, at the beginning of the Tertiary period, there was a massive uplift of the Horn of Africa and its hinterland, which was accompanied by the outpouring of very large quantities of lava. These plateau basalts (so called for the high, flat surfaces which they built up over all previous formations in a series of lava flows) increased to thousands of metres in thickness.

The tensions in this unstable region, associated with an accelerating process of continental drift, resulted in major fractures and the creation of the tectonic formation known as the Rift System. The central portion of this system, which stretches from Syria to Mozambique, separated the Central and Eastern Highlands in the Ethiopian area, where differences in altitude between the floor of the Rift and the surface of the plateau exceed 2000 metres.

Widespread fracturing, the new levels in the landscape and periods of extremely heavy rainfall at the beginning of the Quaternary Period resulted in the channelling of the plateau surfaces and the erosion of the hard protective Trap Series lavas. New rivers plunged through the softer, underlying sedimentary rocks to produce an ever-expanding system of deep gorges, which had their starting point in the Central Highlands along the higher rim of the Great Eastern Escarpment and combined to form the extensive Abay/Blue Nile drainage basin. East of the Rift, the flow was eastwards to the Indian Ocean to form what became the Wabe Shabeelle and the Juba systems. Volcanic activity has continued throughout the Quaternary period on both the high plateau and in the Rift Valley. On the plateau there are the eroded plugs of volcanic vents which were the focal points of recent lava flows. More importantly, on and near the present plateau surfaces are extensive areas of volcanic ash deposits, which in some areas overwhelmed early areas of forest on the plateau. Volcanic activity has been and remains most intensive in the geologically unstable Rift Valley region. Here a variety of features can be seen – volcanoes, calderas, cinder cones, fumeroles and hot springs – some active and many more dormant. Earth tremors are frequent. The Addis Ababa–Nazret area on the fringe of the Rift has some 500 minor tremors a year. This phenomenon is fortunate as the continuous adjustment of tension reduces the frequency of earthquakes with more destructive capacity. These have been experienced in the Rift Valley and its escarpment areas about once every 15 years over the last century, with major quakes at approximately 30-year intervals. A result of all this Quaternary activity, associated with the continuing drift of the African continent away from the Arabian peninsula, has been the build-up on the Rift Valley floor of a variety of lava (the Aden Series), cinder and ash deposits, mixing with alluvial deposits from rivers descending from escarpment areas.

Soils

As a result of the above activity a wide range of soil types exists in Ethiopia and Eritrea. This complexity is accentuated by the wide range in climatic conditions experienced over geological time, from high pluvials to absolute desert and embracing the formation of local icecaps during the Quaternary. These have resulted in moraine deposits on restricted areas of the central plateau lands. Coastal movements over geological time have also produced changes in drainage and erosion patterns and finally – perhaps most importantly in some areas – the long history of human occupation with such practices as slash-and-burn agriculture, cultivation of steep slopes and widespread deforestation has had its impact on soil conditions.

Most tropical soils have a low lime, magnesium, potash and phosphorus content, are poor in humus content and organic matter and do not compare in fertility with soils in the temperate latitudes. The action of climate on soil creates a top layer which is either sandy or clayey and which tends to settle down as a hard surface. Soils which develop in this way are called 'laterite soils'.

Broad soil regions of Ethiopia and Eritrea

No nationwide survey of soils has been made, and present knowledge derives from a number of area studies (e.g. the US Department of the Interior surveys of the Blue Nile basin in the 1950s; various detailed studies of the Awash river basin, beginning with the FAO project documentation of the 1960s; the French Shabeelle basin survey in the 1970s) and the collection of soil samples including the work of the Soil Conservation Research Project (University of Bern with the UN University, Tokyo) initiated in 1981.

There are three significant features of the soils in this region.

a) The richest and most fertile of soils come from igneous rocks. These are found exposed in a belt on the eastern side of Africa associated with the Rift system.

b) The richest soils tend to be the newest soils. Most of the soils on the continent of Africa are derived from the comparatively ancient rocks of the Basement Complex. However, the igneous rocks of East Africa and Ethiopia date from more recent Tertiary and Quaternary eras and, in many areas, the soils have just begun to form.

c) The climatic conditions of the plateau lands do not naturally create the same rapid process of soil creation followed by soil destruction that is found in the warmer lowlands.

The following is a simplified outline of broad soil regions of Ethiopia and Eritrea (see Figure 11). The reader should bear in mind that soil scientists employ a variety of alternative classifications, while the extremely diverse nature of the region leads to many local differences in soil types, which tend to be obscured by general statements about distribution of soil types.

1. The plateau soil region

This is the most extensive area. The parent rocks are basalt and other volcanic rocks of relatively recent formation. The rainfall over this region is high and the red soils which have been formed therefore tend to be laterites. The black vertisol soils (Black Cotton Soils) found in the badly drained areas are formed from the same materials but have the texture and quality of clay. They are more fertile than red earths but are difficult to farm since in the rainy season they are sticky and wet and in the dry season they contract and crack.

2. The crystalline highlands

In these regions (Eritrea, Harar and Borana), the parent rocks are the hard old crystalline materials of the Basement Complex which appear on the surface. The rocks produce poor thin soils, brown or grey-brown, which are acid and not very fertile.

3. The desert soil regions

These regions are arid and semi-arid. In the Afar Plain the soils are formed from very recent volcanic deposits but, since large areas are also represented by dried-out lake deposits, the soils tend to be saline. Soil-forming processes have not produced deep soils and they lack humus. Since they consist mostly of disintegrated rock material they are known as 'lithosols'. In the Ogaden the desert soils are based on sedimentary rocks. Along the Red Sea coast are desert soils based on sedimentary materials and recent marine sediments and these are often potentially rich if irrigated. They are high in phosphorous and potash but low in nitrogen content.

4. Ogaden dry steppe

Soils here are brownish or grey-brown and are based on limestone. They have been formed under conditions of limited rainfall and are therefore only slightly leached. They are rich in carbonates and, with irrigation, they can be very fertile.

5. The Rift lakes

This is a complex soil region. Soils here are based partly on recent volcanic deposits (as in the Afar Plain), partly on lacustrine sediments from the previously more extensive lakes, and partly on alluvial material originating in the plateau regions on either flank of the Rift Valley. Rainfall is limited, especially in the northern part of the Rift lakes, so the soils are only partly leached. The soils of the central Rift and southern Rift are potentially fertile if they can be irrigated.

6. Alluvial plains

River plains often contain soils which are derived from materials transported from the watershed of the river basin. Such alluvial soils are often fertile since they consist of a mixture of materials. In addition, the fertility of alluvial soils is being constantly renewed (in the case of Ethiopia, by eroded top-soil deposits from the lava plateaus). In the formation of alluvial soils, the loss of some regions can therefore be a gain in the alluvial plains. The most important of these alluvial soil regions are found in the lower Abay, the Awash and the Omo valleys and in the more extensive plains of the Baro and Akobo rivers.

THE VEGETATION OF ETHIOPIA AND ERITREA

John Atkins and Sue Edwards

Introduction

Early surveys of Ethiopian and Eritrean vegetation are found in Engler (1910), Logan (1946) and Pichi-Sermolli (1957), the latter producing the first detailed geobotanical survey of Ethiopia. More detailed studies of the vegetation of the region aimed at developing a more objective classification of the region's vegetation have been undertaken by the Flora Project, a collaborative study between the Department of Biology, University of Addis Ababa, and the Institute of Systematic Botany, University of Uppsala, with the Botanical Museum of the University of Copenhagen (*vide* references for the first six of seven planned volumes). Ib Friis of the Botanical Museum of Copenhagen University has been a main contributor to the study of vegetation in the region and Friis (1986) contains an important discussion of forest vegetation types in the region, which forms the basis of the treatment here. In addition, the following have also been referred to in the writing of this account: Last (1965), Mariam (1969), Westphal (1975), Wilson (1977), Chaffey (1979), Negere (1980), Friis *et al*. (1982), Gilbert (1986), Ethiopian Mapping Authority (1988), Tewolde (1988), Friis (1992), Hillman (1993a,b), Tilahun *et al*. (1996) and Federal Democratic Republic of Ethiopia (1997).

After a long period of modification by man, most of the natural vegetation of the region is indiscernible and the small, relatively untouched patches remaining in the highlands now mainly exist only around churches (Negere 1980). Furthermore, the earlier view that all land over 2500m was forested is now regarded as probably mistaken by Hillman (1993a), who argues that much of it was in fact grassland. Reduction of natural forest has come about both through commercial exploitation and by clearance for agriculture, and surviving forests everywhere are increasingly subjected to pressure for charcoal and firewood from the rapidly expanding human population, as well as for cultivation. Huge areas of forest and woodland have disappeared through uncontrolled destruction in recent years, especially close to new access roads. The enforced translocation into western Ethiopia of large populations of highland people during the 1980s has also led to immense losses of areas of forest, which must have resulted in declines in bird populations.

The following eleven vegetation types are based on those in Friis (1986) and in Volume 1, the Natural Resource Base, of the Conservation Strategy of Ethiopia (Federal Democratic Government of Ethiopia 1997).

1. Coastal vegetation
2. Desert and semi-desert vegetation
3. *Acacia–Commiphora*, small-leaved/microphyllous deciduous woodland
4. Riverine vegetation
5. Wetlands and swamp vegetation
6. *Combretum–Terminalia*, broadleaved/macrophyllous deciduous woodland
7. Lowland semi-evergreen forest of Gambela
8. Evergreen bushland
9. Moist evergreen montane forest
10. Dry evergreen montane forest and grassland
11. Afroalpine and sub-afroalpine vegetation

A much simplified distribution of these major vegetation types, except 4 and 5, is given in Figure 9. The map outlines the general bio-climatic regions in which the vegetation types here are distributed. The locations of individual forests and forest patches are only approximate.

1. Coastal vegetation

The main types of coastal vegetation are the plant communities of the coral beaches, sandy shores, deltas, estuaries, dunes and mangrove swamps of Eritrea (Westphal 1975). The basic vegetation of the Red Sea coast consists of scattered clump grasses. After rainfall, annual grasses and other herbs appear. In addition to the grasses there are some larger trees. The vegetation of the coral beaches consists chiefly of salt-tolerant plants, sometimes backed by stands of *Tamarix nilotica*. *Panicum turgidum* is found in coastal sands, and *Suaeda fructicosa* in the estuarine vegetation. On the moving dunes *Scaevola plumieri*, *Calotropis procera*, *Blepharis persica*, *Eragrostis ciliaris* and *Sporobolus* spp. grow. On fixed dunes a varied vegetation of *Acacia*, *Commiphora*, *Grewia* and others is found. Mangrove swamps occur in several coastal localities and sheltered bays, but only very locally, such as on Shek Seyd (Green) Island and at Hirghigo, both near Massawa, and near Assab. They are characterised by *Avicennia marina* and other salt-tolerant species. Plant species typical of the main types of coastal vegetation are listed in the Appendix.

2. Desert and semi-desert vegetation

True desert—zones without plant growth—only occurs in a few limited areas in our region, on alluvial soils below 400m in areas of <250mm rainfall (see Figure 13a). Semi-desert scrubland is found in the Danakil/Afar Depression; along the Red Sea coast and its hinterland; in the eastern parts of the Ogaden; around Chew Bahir and the Omo delta/Lake Turkana area (see Figure 14). This vegetation consists of stunted trees and shrubs (*Acacia*, *Commiphora* etc.) succulents (*Euphorbia* and *Aloe*), and some tough grass species. The poor plant diversity of the Danakil Depression and the Red Sea coast is presumably a reflection of the very low rainfall in those areas. Species typical of the Somali–Masai flora in northern Eritrea include those listed in the Appendix.

By contrast, the Ogaden has a rich plant biodiversity, with many species little known in Ethiopia. The semi-desert Haud is an area of deep, nutrient-poor red sands with many notable plant species (see Appendix). Similar Haud-like flora are also found at lower altitudes in western Sidamo and Gamu Gofa (Gilbert 1986), but further west towards Lake Turkana *Acacia* is more dominant and species diversity is reduced – possibly due to decreased rainfall (Gilbert 1986). The vegetation is poorly known around Lake Turkana and the Omo delta.

This vegetation type is greatly influenced by a variety of factors including wind and water erosion, overgrazing (particularly around watering holes), human population movements due to drought and war, agricultural development schemes requiring irrigation and the use of agricultural chemicals, especially in the Afar region of the Awash valley, on the Gode–Kalafo Plain along the Wabe Shabeelle and at the north end of Lake Chew Bahir.

3. *Acacia–Commiphora*, small-leaved/microphyllous deciduous woodland

This vegetation type, consisting primarily of deciduous bushland or woodland, usually rich in both *Commiphora* and *Acacia* species, occurs mainly in the north, in the central Rift Valley, and in the south and south-east in Hararghe, Bale and Sidamo. The latter area, delimited to the north by the South-eastern Highlands, to the south and east by the borders with Kenya and Somalia, is estimated by Gilbert (1986) to contain one species in four of the Ethiopian/Eritrean flora, a clear indication of its high level of plant biodiversity. *Acacia–Commiphora* woodland occurs at altitudes between 900m and 1900m and forms a semi-arid zone between semi-desert scrubland and the evergreen scrub–grassland–forest mosaic at higher altitudes.

The vegetation varies from very open bushland through to quite well-developed woodland with a closed canopy perhaps 6–7m high (Gilbert 1986). Trees and shrubs are typically drought-resistant, with either small deciduous leaves or leathery evergreen leaves. The understorey is mainly composed of shrubby herbs less than one metre high, and grasses (Tilahun *et al.* 1996).

Altitude, rainfall and the nature of the substrate are the important factors in determining the make-up of the vegetation. In the lowlands of Hararghe and Bale, granite outcrops produce a very coarse sandy soil, which supports a low scrubland–woodland dominated by *Commiphora* spp. Between Negelle and Filtu the main substrate is limestone and is dominated by *Boswellia* and *Commiphora* spp. In the Rift Valley the woodland is largely *Acacia* with only very few *Commiphora* species (Gilbert 1986).

Rainfall within this vegetation type is very localised and unreliable, sometimes none falling for 10 months in a year, and this is probably the most important factor preventing the expansion of settlements. Traditionally such vegetation has therefore been used by pastoralists and their herds. More recently, however, some areas have been cleared for irrigation schemes, such as near Zwai, and other substantial areas are being cut out, particularly *Acacia* species, to supply fuelwood and charcoal for major population centres, including Addis Ababa, Awassa, Arba Minch, Dessie, Mekele etc. (Tilahun *et al.* 1996).

4. Riverine vegetation

The species composition of this vegetation type is very complex, varying with altitude, rainfall, geographical location, soil etc. It is characterised by a diverse range of tree and shrubby species and climbers, with associated herbs and grasses. The Appendix supplies the names of plant species found in riverine vegetation in various parts of the region, ranging from the wadis of eastern Eritrea, the Gash and Barka rivers of western Eritrea, the Danakil Depression, the Awash river, the Dawa river, the highland plateau, the Abay river, to the Baro river in western Ethiopia.

5. Wetlands and swamp vegetation

The main wetland areas in the region (see Figure 14) include the surfaces of major rivers, (especially the Tacazze–Setit, Abay, Baro–Gilo–Akobo, Omo, Awash, Wabe Shabeelle, Genale and Dawa), the large inland lakes (Abaya, Chamo, Awassa, Abiata, Shalla, Langano, Zwai and Tana), and inland swamps (at Lake Chew Bahir, along the shores of the Rift Valley lakes, Boyo, Lake Tana, Lake Afrera, the Awash valley and Lake Abbé). The most extensive wetland areas in the region occur in the Baro–Gilo–Akobo lowlands of Gambela region, the Awash and the Wabe Shabeelle. Wetland vegetation also exists in highland stream valleys and depressions.

The composition of wetland plant species varies greatly from one region to another, depending on altitude, basic geology, chemistry of the water and other factors. For example, along the shores of Lake Tana, vast areas are covered by *Cyperus papyrus* and *Sesbania* species. Along the shores of the Rift Valley lakes occur *Cyperus papyrus*, *Phragmites australis*, *Typha*, *Juncus oxycarpus* and *Scirpus* species. In the arid zone swamps, such as Chew Bahir, north-west of Lake Abbe and Lake Afrera, salt-tolerant plants are common. Plant species characteristic of wetlands in general are included in the Appendix.

6. *Combretum–Terminalia*, broadleaved/macrophyllous deciduous woodland

This is one of the most extensive vegetation types in the region, mainly at 500–1900m in the lowlands of western and north-western Ethiopia, the upper and lower Omo and in western Eritrea. It is composed of small, fire-resistant trees with fairly large, deciduous leaves and an understorey of herbs and grasses (Tilahun *et al.* 1996) There are also large areas of lowland bamboo in the river valleys of western Ethiopia and on some hillsides. The dominant grasses are mainly taller species, such as *Hyparrhenia*. This woodland has been substantially reduced in recent years due to expansion of agricultural activities and the demand for charcoal and fuelwood for major towns.

7. Lowland semi-evergreen forest of Gambela

This semi-deciduous forest is endemic to south-western Ethiopia and adjacent Sudan and has only been relatively recently described (Friis 1992). In Ethiopia it is only known to occur on the plains just south of Gambela, adjacent to, but outside, Gambela National Park. The vegetation type is generally poorly known, but one area between Abobo and Gok, at 450–600m, is in relatively flat country, on well-drained sandy soils, with ground water not far below the surface. Mean annual temperatures are very high, at 35–38°C, while most of its annual rainfall of 1300–1800mm falls between May and September.

This vegetation type is characterised by a 15–20m tall, more or less continuous canopy of *Baphia abyssinica,* mixed with a few emergents and several other less common species. Below the closed canopy is a further, more or less continuous, layer of smaller trees. There is also a shrub layer, which is generally not dense. Lianas are not prominent, but thorny woody climbers make walking in the forest difficult. There appear to be no epiphytes and generally the forest floor has very few species.

The forest is severely threatened, partly by the rapid expansion of Gambela town and other settlements in the region, and partly by the

Abobo dam, which has already flooded a substantial part of the forest (Tilahun *et al.* 1996). Large-scale irrigated agricultural development is envisaged in the area in the future. The forest is little known ornithologically.

8. Evergreen bushland

This vegetation type occupies an intermediate zone between the humid and semi-arid vegetation types. It is often intermixed with woodland and cultivated land. Since it occurs adjacent to dry and moist evergreen forested areas, it may be found at any altitude where such forests are found, although this feature is not possible to show on Figure 9. It is particularly common on the steep slopes of the Abay river and its tributaries. The denser evergreen scrub occurs on the humid south-western and western side of the region.

Evergreen scrub expands as forested areas are cleared. For example, in the south-west of Ethiopia large areas of moist evergreen forest have been cut down for timber and coffee plantations (e.g. at Bebeka in Kefa), while other areas within forest blocks are being deforested for small-scale, often slash-and-burn agriculture. Evergreen scrub is an initial stage of vegetation regrowth in such areas. Unfortunately with increasing population pressure such vegetation may not be given time to regenerate through all the transitional stages of regrowth in order for true forest to be re-established. Evergreen scrub is disappearing at an alarming rate close to big towns where the demand for fuelwood is acute.

9. Moist evergreen, montane forest

This vegetation type occurs mainly in the western and south-western parts of the plateau at up to 2800m and 1500mm rainfall, in south Bale and north Borana, and at 1500–2500m and at 1500–2650mm in west Welega, Illubabor and Kefa (Tilahun *et al.* 1996). One important example in the south-east is the Harenna Forest on the southern slopes of the Bale Massif. This forest type is marked by tall, emergent, medium-sized trees, and by understorey shrubs. At drier and higher altitudes it is characterised by *Afrocarpus (Podocarpus) gracilior*, in the lower wetter areas by *Pouteria (Aningeria) adolfi-fredericii*, known locally as 'keraro'. Plant endemism is not high, although a number of endemic herbs and epiphytes are found. The following account follows Friis (1986) who has recognised three subtypes of moist evergreen forest vegetation.

a. Humid mixed forest around the southern part of the Rift Valley and in Hararghe

This type occurs at 1500–2600m, with average annual temperatures 15–20°C and rainfall of 700–1500mm, most between April and September. It typically contains a mixture of *Podocarpus*, *Pouteria (Aningeria) adolfi-fredericii* and broadleaved species in a canopy of 10–30m, smaller trees and large shrubs, lianas, epiphytes and lush ground cover. Harenna Forest on the southern side of the Bale Mountains is one of the largest areas of this type of forest, although it has been severely damaged by fire and depleted by logging. Other forests of this type include Anferara-Wadera and Bore-Anferara between Agere Selam and Kebre Mengist, which contain a wide range of species with a similar canopy height and a ground cover rich in ferns, grasses and herbaceous dicotyledons.

Moist evergreen montane forest: Harenna Forest, Bale Mountains National Park, Ethiopia (John Atkins).

b. Humid broadleaved forest of the south-western part of the plateau in southern Welega, Illubabor and Kefa

This forest type is widely distributed in the south-western highlands at 1500–2500m, in areas with an annual temperature range of 18–20°C and 1500 to over 2000mm of rain throughout the year, but most in April–October.

One emergent species, *Pouteria (Aningeria) adolfi-fredericii,* dominates this forest with a canopy of 10–30m, although there are at least 20 canopy species involved. Apart from smaller trees, numerous shrubs, lianas, scrambling shrubs and a wide range of epiphytes, including ferns and orchids, occur and over 100 species of herbaceous plants are known. This zone merges into *Acacia abyssinica* woodland, part of the dry forest–woodland–grassland complex.

c. Transitional forest of the south-western escarpment

This vegetation type forms a transition between the lowland forests of Gambela and the broadleaved forests of the mountains. It is found at altitudes of 800–1500m, partly in river valleys, especially those of the Baro river and its tributaries on the south-western escarpment of the same area of Ethiopia as 9b. It closely resembles the forests in 9b, but includes a number of species typical of those in 7 above. Moist evergreen forests have been damaged and are now increasingly and severely threatened by unplanned and uncontrolled exploitation for timber (which has led and continues to lead to a substantial reduction in the size and species composition of forests, because selected species are targeted), by commercial coffee-growing operations (e.g. at Bebeka in Kefa, Gumero in Illubabor and Harenna in Bale) and by changes in living patterns. In particular there is a steady increase in settlements within forest blocks, accompanied by more sedentary agricultural practices and, combined with greater access to markets as new roads are opened up, this is resulting in further deforestation.

10. Dry evergreen montane forest and grassland

Friis (1986), on whose work the following account is based, describes three subtypes of dry evergreen forest: the dry forest of Eritrea and the eastern escarpment; the dry forest of the highland plateau; and the dry forest of Sidamo, Bale and Hararghe. All these forests occur in patches, associated with grassland, acacia woodland and evergreen scrub.

a. The dry forests of Eritrea and the eastern escarpment

In Eritrea, dry evergreen montane forests occur in patches in the north and on the eastern escarpment on rocky ground with high drainage at 1600–2400m. Similar forests occur on the eastern-facing escarpment in Tigray, Welo, Shewa and in the Chercher Highlands. Annual rainfall here is presumed to be between 400 and 700mm. The period of maximum rainfall is from October to March in the relatively restricted area with winter rain in Eritrea, while maximum rainfall is from July to August in the southern part of the area. The average annual temperature varies from 18 to 20°C. Such dry forests are dominated by *Juniperus* near Halai, at Cohaito, at Mrara and on Saber Mountain in Eritrea, and at Wofwasha forest near Ankober. For other species associated with this type of forest, see the Appendix. On the eastern side of the escarpment, the forest is of a drier type, presumably because of the rocky soil, unimpeded drainage and higher average temperatures. The present status of these forests is unclear.

b. The dry evergreen montane forest of the highland plateau

Dry evergreen montane forests associated with *Acacia* woodlands and grasslands occur in much of the highlands in the northern and north-western, central and south-eastern parts of the region. On the north-western plateau, this vegetation type occurs at 1900–3400m, where there is 800–1500mm of rainfall. There are two main rainy seasons, March–April and August–September, generally increasing as one moves from north to south, although considerable variation results from such factors as direction of slope in relation to prevailing rain-bearing winds. Mean annual temperatures are between 14 and 18°C.

This forest is really a forest–woodland–grassland complex characterised by small to large trees and extensive grasslands rich in legumes. Common tree, shrub and grass species are listed in the Appendix. The ecotone between forest and grasslands is occupied by *Acacia* woodland. This vegetation type is particularly important for a large number of endemic plants.

Since this is the zone where settled communities with a cereal-based agriculture have existed for thousands of years, and where most of the population of the region now lives, the natural vegetation is very much reduced. Much forest has been replaced by woodland and grasslands on gentler slopes, and by evergreen bushland on steeper slopes (Tilahun *et al.* 1996). The few larger forest patches are widely separated from each other by areas of cultivation and wooded grassland, while the primary species of the wooded grasslands of the plateau are similarly dispersed and must have long existed in similar habitats. Thus the forest patches, grasslands and *Acacia* woodlands have apparently long existed in a complex, in which wooded grasslands occupy the less favourable areas and forests the more favourable. Where there is little human activity, *Acacia* woodland may be seen as a stage in the natural regeneration of dry montane forest. Small forest patches still exist around many churches, where they were protected for centuries, although it is unlikely that any are now entirely in their original state.

In the dry forests of the north and north-western highland plateau, the typical dominant species in the upper storey are junipers and olives. South of Lake Tana the natural forest of the plateau was probably mixed *Afrocarpus (Podocarpus) gracilior–Juniperus procera*, which presumably covered more extensive areas in Shewa, and which is a transition type to the humid forests with conifers in Sidamo (Borana) and Hararghe. Menagesha forest, west of Addis Ababa, is one of the best-preserved examples, although *Podocarpus* is not common there. A second is Chilimo forest, also west of Addis Ababa. In the southern part of the plateau the 20–30m high canopy of *Juniperus procera* and *Podocarpus gracilior* has a stratum of small to medium-sized trees, below which are small trees and shrubs. Common species are listed in the Appendix.

At the upper limit of this type of forest, above 3000–3400m and sometimes surrounding the forest at lower altitudes, more open woodland or evergreen bushland is frequently found, sometimes containing *Erica arborea*, *Hagenia abyssinica* and *Hypericum revolutum*.

The forest on the shores and islands of Lake Tana, influenced by its more humid environment, forms a transition to the humid evergreen forests of south-western Ethiopia, and is not strictly riparian. Common species within the 20–25m canopy and lower stratum of this forest are listed in the Appendix.

c. The dry forests of Sidamo, Bale and Hararghe

The dry juniper forests of Sidamo (Borana), Bale and Hararghe occur at 1500–2200m, have a range of temperatures at 20–25°C and of rainfall at 400–700mm, distributed in two rainy seasons, April–May and September–October. In Sidamo they are found at Arero, Yavello, Mega and Negelle. The dry forest south of Negelle is very open, almost juniper woodland with a canopy 10–15m high and is often associated with woodland or evergreen bushland at the fringes. The undergrowth consists of evergreen bushes with open grassy glades in between. Unfortunately many of these forests have been depleted by logging and ravaged by fires. Typical species are listed in the Appendix.

11. Afroalpine and sub-afroalpine vegetation

Much of this vegetation occurs on the slopes and at the tops of the highest mountains in Ethiopia, on mostly basaltic rocks above 3200m. Thus it occurs in the Simien Mountains (Ras Deshen, 4620m), the Lasta Masif (Mount Abune Yosef, 4284m), the Guna Massif (Mount Guna, 4231m), Mount Kollo (4300m), the Choke Mountains (Mount Choke, 4154m), the Gurage Massif (Mount Gurage, 3697m), the Gughe Massif (Mount Gughe, 4176m), the Amaro Mountains, Mount Chilalo (4005m), Mount Badda (4133m), Mount Kaka (4200m) and the Bale Mountains (Mount Batu, 4307m) (Westphal 1975). It is the major vegetation type of the Simien Mountains and Bale Mountains National Parks. At lower altitudes it is characterised by small trees, shrubs and shrubby herbs and at higher altitudes by giant herbs, small herbs and grasses (Tilahun *et al.* 1996).

At lower altitudes, in the sub-afroalpine belt, the most extensive vegetation is of ericaceous scrub—*Erica arborea* in the northern mountains and *E. trimera* in southern Ethiopia. On slopes this scrub grows on very thin soil. Conditions for plant growth, particularly soil temperature, are more favourable than at higher altitudes, but are still poor. Areas of deeper soil in the sub-afroalpine belt support more species of woody plants. The poorly drained flatter areas support meadows and marsh or aquatic vegetation. This belt is a very important source of dry-season water for permanent streams.

This extremely fragile environment is greatly threatened by overgrazing, fire and expansion of barley cultivation, particularly on the steeper slopes, which are being devastated by sheet erosion.

Table 1. Plant species typical of major vegetation categories (see first page of chapter for category titles).

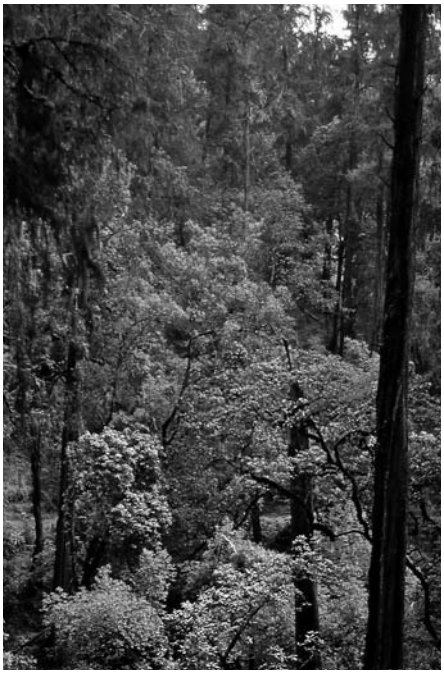
Name[1]	Plant type and remarks	1	2	3	4	5	6	7	8	9a	9b	9c	10a	10b	10c	11
Acacia abyssinica	spreading tree to 20m				x						x		x	x	x	
Acacia brevispica	shrub or small tree to 7m			x												
Acacia drepanolobium	whistling thorn acacia, small tree to 5m			x											x	
Acacia ehrenbergiana	small shrub or small tree to 4m	x	x													
Acacia etbaica	small tree to 12m			x					x				x		x	
Acacia horrida	shrub to 4m		x	x	x											
Acacia mellifera	shrub or tree to 8m, 'won't let go'		x	x												
Acacia negrii	endemic, tree up to 10m													x		x
Acacia nilotica	tree to 14m			x											x	
Acacia oerfota	shrub to 5m		x	x												
Acacia pilispina	shrub or tree to 15m												x			x
Acacia polyacantha	tree to 20m			x	x		x	x								
Acacia senegal	shrub or tree to 10 (15) m			x					x							
Acacia seyal	tree to 9m			x			x	x					x		x	
Acacia tortilis subsp. *spirocarpa*	tree to 21m		x	x												
Acacia tortilis subsp. *tortilis*	small tree c 4m	x	x													
Acanthus spp.	small shrubs								x				x	x	x	
Acokanthera schimperi	tree to 5m								x				x		x	
Adansonia digitata	baobab, large tree only in Tacazze valley				x		x									
Adenium obessum	shrub called desert rose		x													
Aerva spp.	herbs		x	x												
Aeschynomene elaphroxylon	balsa wood tree					x										
Afrocarpus (*Podocarpus*) *gracilior*	african podo, emergent forest tree to 35 m tall									x	x		(x)	x	x	
Agrostis spp.	grasses													x		x
Albizia spp.	small to large trees with shiny leaves				x			x	x		x	x		x		
Alchemilla spp.	creeping & climbing herbs							x						x		x
Alcomea laxiflora	shrub or small tree to 7m				x			x	x							
Allophylus spp.	shrubs and small trees								x	x	x			x		
Aloe spp.	perennial succulents		x	x					x					x		
Anogeissus leiocarpus	shrub or tree to 10m						x	x	x							
Anthocleista schweingurthii	tree to 25m											x				
Apodytes dimidiata	tree to 20m				x						x			x		
Aristida spp.	grasses with piercing fruits		x	x												
Arthrocnemum glaucum	succulent herb	x														
Arundinaria alpina	montane bamboo									x	x			x		
Atriplex spp.	saltworts	x														
Avicennia marina	mangrove	x														
Balanites aegyptiaca	desert date, evergreen shrub or small tree			x					x							
Baphia abyssinica	tree to 10m							x								
Barbeya oleoides	bush or small tree to 10m								x				x		x	
Barleria spp.	shrubs or herbs			x												
Bartsia petitiana	herb															x
Bersama abyssinica	shrub or small tree to 15m								x	x	x	x		x		
Blepharis spp.	creeping herbs	x	x	x												
Boswellia spp.	incense (frankincense) trees		x	x				x								
Breonardia salicifolia	tree to 20m															
Brucea antidysenerica	shrub or small tree to 5m (10m)								x	x	x		x	x		
Buddleja polystachya	shrub or small tree to 10m								x				x	x		

Name[1]	Plant type and remarks	1	2	3	4	5	6	7	8	9a	9b	9c	10a	10b	10c	11
Cadaba spp.	shrubs		x	x												
Cadia purpurea	shrub								x						x	
Calpurnia aurea	shrub or small tree to 5m (10m), pioneer								x	x	x		x	x	x	
Capparis spp.	tangled spiny shrubs			x					x							
Caralluma spp. and other stapeliads	perennial succulents		x	x												
Carex spp.	sedges					x					x			x		
Carissa edulis	shrub to 5m				x				x					x	x	
Celtis spp.	small to large trees				x			x			x	x		x		
Cenchrus spp.	African foxtail grasses		x	x										x		
Chionanthus mildbraedii	shrub or small tree to 10m				x					x	x			x		
Chrysopogon plumulosus	tussock grass		x	x												
Cissus spp.	climbers, some with succulent stems			x					x				x	x		
Clematis spp.	climbers, 'old man's beard'					x			x		x		x	x		
Clitoria ternata	butterfly pea				x			x				x				
Coffea arabica	shrub or small tree									x	x	x		x		
Combretum spp.	broadleaved trees to 8m			x			x	x	x						x	
Commiphora spp.	incense (myrrh) shrubs and small trees	x	x	x					x							
Cordeauxia edulis	yehib nut, shrub or small tree		x	x												
Cordia africana	small to large tree to 25m									x	x		x	x		
Cornulaca ehrenbergii	small shrub with succulent leaves	x														
Crotalaria spp.	small to medium-sized leguminous shrubs			x	x	x	x		x		x		x	x		
Croton machrostachyus	shrub or small tree to 8m in open places, and to 25m in forests								x	x	x		x	x	x	
Croton sylvaticus	forest tree to 25m											x				
Cyathea manniana	tree fern											x				
Cymbopogon spp.	turpentine and lemon grasses		x	x			x	x								
Cymodoceaceae	eel grass family	x														
Cyperus papyrus	papyrus					x										
Cyperus spp.	sedges					x										
Dactyloctenium spp.	creeping grasses		x	x												
Diospyros abyssinica	tree to 8–15m				x			x						x		
Dipterygium glaucum	herb or small shrub	x														
Dodonea angustifolia	shrub or small tree to 8m								x					x	x	
Dovyalis abyssinica	shrub or small tree to 9m				x					x			x	x		
Dracaena spp.	shrubs to small trees									x	x	x		x		
Dracaena ombet	dragon tree		x						x							
Echinochloa spp.	tall swamp grasses					x		x								
Ehretia cymosa	shrub or small tree to 15m						x		x					x		
Ekebergia capensis	tree to 30m									x	x		x	x	x	
Elaeodendron buchananii	tree to 20m				x							x				
Eleocharis spp.	sedges					x										
Eleusine spp.	grasses													x		
Eragrostis spp.	grasses													x		
Erica spp.	tree heather, shrubs or trees to 8m															x
Erythrina brucei	endemic soft-wooded tree												x	x		
Euclea spp.	evergreen shrubs or small trees				x				x				x	x		
Euphorbia ampliphylla	forest tree euphorbia, tree to 30m									x	x			x		
Euphorbia spp.	succulent herbs and shrubs		x	x			x		x							
Euryops spp.	small shrubby herb															x

Name[1]	Plant type and remarks	1	2	3	4	5	6	7	8	9a	9b	9c	10a	10b	10c	11
Festuca spp.	tussock grasses															x
Ficus spp.	fig trees, some very large indeed				x		x	x		x	x	x		x		
Galiniera coffeoides	undershrub									x	x			x		
Gnidia glauca	shrub or small tree to 10m													x		x
Hagenia abyssinica	kosso, tree to 20m									x				x		x
Helichrysum spp.	everlasting flowers								x				x			x
Hyparrhenia spp.	tussock grasses						x	x	x				x	x		
Hypericum revolutum	St John's wort, shrub or tree to 8m									x			x	x		x
Hyphaene thebaica	doum palm	x			x											
Ilex mitis	shrub or tree to 30m									x			x	x		x
Jasminum spp.	climbers								x				x	x		
Jatropha spp.	semi-succulent herbs and small shrubs		x	x												
Juncus spp.	rushes					x										
Juniperus procera	juniper, tree mostly to 20m tall, but can get to 45m tall									x			x	x	x	
Justicia (*Adhatoda*) *schimperiana*	shrub, often as a live fence								x		x		x	x		
Knipfolia spp.	'red hot poker', herbs with fleshy leaves												x	x		x
Lannea spp.	small trees						x	x								
Lepidotrichilia volkensii	shrub or tree to 15m									x	x			x		
Limonium spp.	stachys, herbs	x	x													
Lobelia rhynchopetalum	giant lobelia, flowering stem to 9m															x
Macaranga capensis	small tree to 15m									x	x	x				
Manilkara butugi	tree to 30m											x				
Millettia ferruginea	tree to 20m , local endemic									x	x	x		x	x	
Mimusops kummel	tree to 25m				x									x		x
Nuxia oppositifolia	shrub or small tree to 3m, sometimes to 20m								x				x	x		
Ocotea kenyensis	tree 20–35m tall											x				
Olea europaea subsp. *cuspidata*	african olive, tree to 20m												x	x	x	
Olea capensis	tree to 30m									x	x	x		x		
Olinia rochetiana	shrub or small tree to 15m												x	x		
Oncoba spinosa	small tree to 10m				x		x		x					x		
Oxytenanthera abyssinica	solid-stemmed lowland bamboo						x	x								
Panicum turgidum	turgid panic, tussock grass	x	x													
Pennisetum spp.	creeping and tussock grasses													x		
Phoenix reclinata	wild date palm				x				x			x				
Phragmites australis	reed grass					x										
Pistacia aethiopica	shrub or tree to 12m								x				x		x	
Pittosporum spp.	small trees to 12m				x				x		x		x	x	x	
Polyscias fulva	tree to 30m									x	x			x		
Pouteria (*Aningeria*) *adolfi-fredericii*	emergent tree to 45m									x	x	x		x		
Pouteria (*Aningeria*) *altissima*	emergent tree to 40m											x				
Protea gaguedi	small tree to 9m, bark fire resistant								x					x	x	
Prunus africana	tree to 25m									x	x			x		
Psychotria orophilla	shrub or small tree to 8m									x	x					
Pterolobium stellatum	climber with vicious thorns								x				x			
Rhizophora mucronata	mangrove	x														
Rhus spp.	shrubs and small trees			x	x				x				x	x		
Rosa abyssinica	shrub or small tree								x				x	x		
Salsola spp.	saltworts	x				x										
Salvadora persica	evergreen bush or small tree		x	x												

Name[1]	Plant type and remarks	1	2	3	4	5	6	7	8	9a	9b	9c	10a	10b	10c	11
Sansevieria spp.	perennial herbs		x	x												
Schefflera abyssinica	tree to 30m				x					x	x			x		
Schrebera alata	shrub or small tree to 10m tall										x		x	x	x	
Scirpus spp.	sedges					x										
Sesbania spp.	small trees					x					x			x		
Solanecio spp.	giant herbs								x	x	x			x		
Sporobolus spp.	tough tussock grasses		x	x										x		
Stereospermum kunthianum	small fire-resistant tree						x	x								
Strychnos mitis	small tree to 15m										x	x		x		
Suaeda spp.	saltworts	x	x			x										
Syzygium guineense	small to large tree to 25m				x		x				x			x		
Tamarindus indica	tamarind, large tree to 20m				x		x									
Tamarix spp.	tamarix, small trees	x	x		x	x			x							
Tarchonanthus camphoratus	shrub to 7m, smelling of camphor												x		x	
Teclea nobilis	tree to 15m				x						x		x	x		
Terminalia spp.	broadleaved trees			x	x		x	x	x							
Trichilia spp.	trees to 30m				x		x			x	x	x				
Trifolium spp.	clovers, herbs												x	x		x
Trilepisium madagascariense	tree to 20m										x	x				
Turraea holstii	shrub or small tree to 10m				x						x			x		
Typha spp.	cat's tails / bulrushes				x	x										
Vepris dalnellii	small to medium-sized tree to 15m										x	x				
Warburgia ugandensis	tree to 20m									x						
Whitfieldia elongata	shrub to 2m							x								
Zanha golungensis	tree to 10m							x								
Ziziphus spp.	shrubs and trees			x	x		x	x	x							
Zygophyllum spp.	succulent herbs and shrubs	x	x													

[1] The scientific names are those used in the *Flora of Ethiopia and Eritrea* (Edwards *et al.* 1995, 1997, 2000; Hedberg & Edwards 1989; Hedberg *et al.* 2003, 2006; Phillips 1995; Tadesse 2004)



Above: Dry juniper forest, Demhina, eastern escarpment, Eritrea (Jason Anderson).

Left: Dry evergreen montane forest: Menagesha Forest near Addis Ababa, Ethiopia (John Atkins).

THE CLIMATE OF ETHIOPIA AND ERITREA

Introduction

Eritrea and Ethiopia both lie in the northern tropics, between the equator and the Tropic of Cancer, but internally the climate is greatly influenced by altitude and aspect, which determine temperature, rainfall and potential evapotranspiration. Temperature is affected by latitude, altitude, winds, rainfall and humidity; rainfall by the Intertropical Convergence Zone (ITCZ) and altitude; potential evapotranspiration (PET) by all the above factors. There is much microclimatic variation within the different vegetation zones of the region, with over 30 agro-climatic 'zones' recognised. These points are discussed briefly to help in an understanding of the climatic patterns in both countries, based mainly on information from Westphal (1975) and Ethiopian Mapping Authority (1988). Gamachu (1988), Griffiths (1982), Last (1965), Liljequist (1986), Tilahun *et al.* (1996) and Yalden (1983) have also been consulted. A simplified map of the main rainfall regimes and climatic regions in the region is given in Figure 12.

Temperature

Both countries lie between 3° and 18°N with a low annual average range of temperature, but a high daily range in much of their area. Tropical conditions are experienced generally below 1500m, whilst warm to cold temperate conditions exist above this altitude. As expected, the highest temperatures are found at the lowest altitudes (e.g. a mean monthly figure of 45°C, from April to September, in the Danakil or Afar Depression down to 110m b.s.l.) and the lowest mean temperatures of 4°C or below at the highest altitudes, over 3600m a.s.l. in the Simien Mountains.

The thermal climate is so clearly affected by altitude that Ethiopians have traditionally classified their country into five climatic zones according to altitude and mean annual temperature: *Bereha*, *Kolla*, *Woina Dega*, *Dega* and *Wurch.*

Table 2. Ethiopian climatic zones.

Zone	Altitude	Climate	Average Annual Temperatures
Bereha	<500m	hot arid	28–34°C
Kolla	500–1500m	warm to hot, semi-arid	20–28°C
Woina Dega	1500–2500m	warm to cool semi-humid	16–20°C
Dega	2500–3200m	Cool to cold humid	10–16°C
Wurch	>3200m	Cold, moist	<10°C

On the highland plateau the hottest month is usually May, while in December the temperatures can fall to below freezing at night. In the western lowlands the hottest months are April to June, with temperatures of up to 50°C. On the coast, in the eastern lowlands and on the islands, the temperature can range from 40° to 50°C between June and September. The high night-time temperatures in the eastern lowlands and coastal areas result in very high average temperatures for these areas. All areas of the highland plateau experience a noticeable drop in average day temperatures after the onset of the big rains in June–July. Frost can occur during dry periods with clear skies in *Dega* and *Woina Dega* regions and is known to occur down to 1500m. Temperature varies seasonally depending on whether the sun is directly overhead (as in March–September) or not, as well as altitude, cloud-cover and local microclimatic factors. Locally the aspect of the land in relation to the sun affects temperatures and moisture retention, as also does the direction of prevailing rain-bearing winds.

Rainfall

Annual rainfall amounts vary greatly over the region, with some areas in semi-arid and desert zones receiving only 100–400mm, while others in the mountainous areas receive more than 2000mm (Figure 13a). There are very pronounced fluctuations from year to year (Westphal 1975, Griffiths 1982) with the El Niño phenomenon of the Pacific Ocean having a strong influence. For example rainfall in some areas during the months from January to June may vary over a succession of years from very small amounts to amounts more typical of a wet season. Sometimes in the highlands the small rains merge into the big rains, causing a continuous rainy season from March to September, though usually they are separated from each other by a short dry period. Moreover in most years the main wet season in the highlands will be interrupted by rainless spells lasting several days, while in a dry season there may be sudden unexpected heavy rainfall, due to unsteady pressure systems.

Of particular importance to rainfall is the influence of the ITCZ, whose seasonal meridional displacement, with a northerly position in the northern hemisphere summer and a southerly position in the winter, causes a variation in the wind-flow patterns over both countries (Liljequist 1986). The ITCZ passes over them twice a year, alternately causing the onset and withdrawal of winds from north and south. Broadly speaking, this results in two seasons in the region, a wet season from June/July to September, influenced by south-westerly winds blowing from the Atlantic Ocean, and a dry season from October to January/February, influenced by north-easterly winds (Figures 13c–d).

The south-westerly monsoon to the south of the ICTZ prevails over most of the region between June and September, bringing moisture-laden winds from the Gulf of Guinea, the Congo Basin and Central Africa. As these winds ascend over the highlands, they cause thunderstorms and very heavy rains and result in the 'big rains' season, known as *Krempt,* meaning 'time of staying in one place', in most of Ethiopia and highland Eritrea (Figure 13c). The south-west experiences the longest duration of *Krempt* rains, because the rain-bearing winds both advance and depart through this area. The shortest duration of rains is in the extreme north-east, where they last for two months or less. Rainfall thus lessens towards the north and often ceases when it reaches the upper slopes of the eastern escarpments of the north-western highlands in Ethiopia and Eritrea. These highlands and associated lowlands of northern Ethiopia and Eritrea generally remain dry during this period because they are rain-shadow areas, while the south-eastern highlands and lowlands of Ethiopia remain dry because they are under the influence of dry southerly winds from the Indian Ocean. They receive rain in two short seasons.

The period from October to the end of January/early February is, generally speaking, the period of lowest rainfall in Ethiopia and most of Eritrea (Figure 13d). At this time the ITCZ has moved to the south and the region is experiencing the dry north-east trade winds from the Indian Ocean. South-western Ethiopia, which is still influenced by the gradually departing south-westerly rain-bearing winds, still receives moderate rain, but for the rest of the country this period contains the period of spring (*Tibi metsaw*) in October–November, followed by the hot dry season, known as *Bega.* However, within the same period, the escarpments of the Eritrean Highlands facing the Red Sea receive their heaviest rainfall and the adjacent coastal plains also receive a moderate amount of rain due to the influence of the Red Sea.

Between late February and May, the ITCZ lies across southern Ethiopia (Figure 13b). In March moist easterly and south-easterly winds from the Indian Ocean begin to blow across central and southern Ethiopia and produce the main rains for the south-eastern highlands, including Bale, and increasingly in April/May for the lowlands of the Ogaden, Borana and southern Sidamo. The same winds cause the small spring rains, known as the *Belg*, or 'time of ploughing', in the central highlands of Ethiopia and the northern highlands of Eritrea. In some highland areas towards the west there is more or less continuous rain from March to September, with the short rains merging with the long rains.

The following broad rainfall regimes, based on Westphal (1975) and EMA (1988), can be recognised (See Figure 12):

1. Central, eastern and northern areas of the region are affected by both westerlies and easterlies and experience two periods of rain. The big rains from June/July to September derive from the Atlantic, while the small rains between February and May are carried by winds from the Indian Ocean. A short transitional period marked by a decrease in rainfall occurs when the moisture-bearing winds shift from east to west. The amount of rainfall and the length of the wet season decrease from south to north and west to east.

2. In western and south-western parts of the region there is broadly a single period of rainfall. This is the result of wind systems from the Indian Ocean combining with moist air from the Atlantic to provide continuous rain from March or April to October or even November. Again the amount of rainfall and the length of the wet season decrease from south to north.

3. Southern and south-eastern parts of the country experience two periods of rainfall caused by the easterly wind system from the Indian Ocean. Rain falls from March to May (50–60% of annual rainfall) and from September to November (25–35% of annual rainfall). The months in which rainfall is most likely are April and May.

4. The north-eastern lowlands, including the Red Sea coastal plains and slopes of the nearby escarpment to 15°N, experience only one rainy season, from November/December–February/March, when only light, sporadic rain falls.

5. The eastern slopes of the Eritrean Highlands, from 15°N, experience a rainfall regime with maxima in December–February and July–August. These two periods together supply 55–70% of the area's total rainfall. One small area of the Eritrean eastern escarpment north of Ghinda, including Semenawi Bahri, receives an annual total rainfall in excess of 1000mm, with rain in every month except June and September, and is thus a relatively wet zone with lush vegetation. This is also an extension of the Mediterranean winter rains, reflected in the Mediterranean elements in the flora.

However, in addition to the effects of the Intertropical Convergence Zone, there are significant variations in rainfall from place to place in Ethiopia and Eritrea, caused by altitude and by microclimatic variations created by local relief differences and prevailing winds (Last 1965). Due to the highly dissected nature of the relief of the region, these local features are extremely important in determining rainfall and, particularly in highland areas, there are significant variations in local microclimates within small areas, which in turn may lead to much higher rainfall there. The highland areas east of Lake Tana (the Simiens), in central Gojam (the Choke Mountains) and east of Lake Abaya (the Amaro Mountains) stand out, for example, as islands of higher rainfall (Westphal 1975). The distribution or lack of distribution of rainfall in mountainous areas depends on the prevailing winds and on the orientation of the mountain slopes. In mountainous areas where the direction of the prevailing wind is more or less the same for long periods, windward slopes, with ascending airflow, typically obtain ample amounts of rain. Thus highlands with slopes facing the south-west winds during the Krempt rains receive heavy precipitation. Leeward slopes and valleys, however, which receive descending air currents, are then situated in rain-shadow areas, and obtain less or no rain (Liljequist 1986). For example, the coastland of Eritrea and the Danakil Desert, situated to the east of the escarpment facing eastward, are dry in the summer when the south-west winds are blowing because at that time they are situated in the rain-shadow of the western highlands. The air currents descending the escarpment are warmed and give practically no moisture to the plains of the lowlands to the east or to the coastline of Eritrea (Liljequist 1986).

Potential evapotranspiration (PET)

The effect of rainfall primarily depends on the evaporation rate and, as evaporation rates vary substantially with altitude, latitude, season, etc., evaporation studies are highly important for the interpretation of rainfall data. Where rainfall is always equal to potential evapotranspiration there is neither water surplus nor deficiency and the climate is neither humid nor dry (EMA 1988). Areas where excess of rainfall over potential evapotranspiration (PET) are the highest can be assumed to be the most humid, wettest areas in the region, while the driest areas are those where PET excess over rainfall is the highest. Mean annual evapotranspiration in Ethiopia and Eritrea is highest in the north-eastern and south-eastern areas and lowest in the western parts of the country. It ranges from over 3000mm in the Danakil Depression to less than 1200mm in the southern and western highlands, due to a combination of rain and cloud cover (Tilahun *et al.* 1996).

Climatic regions

The following modified Köppen classification of overall climatic regions of Ethiopia and Eritrea, based on EMA (1988) and Westphal (1975), themselves based on Delliquadri (1958), illustrates the annual and monthly means of temperature and rainfall, seasonal changes of rainfall and the types of indigenous vegetation associated with each region (see Figure 13).

Hot, arid, desert climate

Desert regions of western Eritrea, the coastal plains bordering the Red Sea, the Danakil Plains and north-eastern lowlands, the area north of Lake Turkana, Chew Bahir and south-eastern Ethiopia. The vegetation is barren to sparse. Average monthly temperatures

>18°C with low rainfall and high PET. Mean annual temperatures 27–30°C. Mean annual rainfall <450mm. Climate usually characterised by strong winds, high temperatures, low humidity and little cloud. Evaporation may be 20 or more times in excess of rainfall.

Hot semi-arid climate

Western Eritrea, north-western Ethiopia, eastern slopes of the Eritrean highlands, eastern slopes of the central and northern Ethiopian highlands, Rift Valley as far south as Lake Shalla, escarpments of the south-eastern highlands, and Omo river valley. Steppe vegetation. Mean annual temperatures 18–27°C. Mean annual rainfall 410–820mm, and highly variable from year to year. Evaporation exceeds rainfall, so no permanent streams.

Cool semi-arid climate

Southern highlands of Eritrea above 2000m, northern Tigray and highlands east of Jijiga. Steppe vegetation. Mean annual temperatures 12–18°C. Mean annual rainfall 400–620mm. Evaporation less than in previous category, due to generally lower temperatures, thus the zone is less arid.

Tropical climate 1

A small area of the eastern escarpment of the Eritrean highlands between Asmara and Massawa. Vegetation is low bushes and grasses. Mean temperature of coldest month is >18°C. Mean annual rainfall 680–1200mm. Main rains in November–February/March, but rain falls in every month except June and September.

Tropical climate 2

From west of Omo, north through the lowlands of the Akobo, Didessa and Abay river basins, the western slopes of the Ethiopian highlands, to the Tacazze valley, where summer rain only. Generally annual rainfall decreases from south-western parts to northern and eastern parts, though lengths of wet and dry periods vary considerably. Also central Illubabor, the areas surrounding Jimma, and the Chercher highlands, where spring and summer rain. From lowland plains up to 1750m. Typical vegetation consists of tall grasses, or grass and trees intermingled. Mean temperature of coldest month >18°C. Mean annual rainfall 680–2000mm. November–February generally dry.

Tropical climate 3

South-western Ethiopia, in Kefa and Illubabor and around Lake Tana. Up to 1850m. Vegetation typically evergreen forest. Temperature regime similar to previous category, but because of higher altitudes at which it often occurs, temperatures slightly lower. Mean temperature of coldest month >18°C. Higher annual rainfall and dry season shorter. Two rainfall maxima, with most rain June–September. Mean annual rainfall 1200–2800mm.

Warm temperate climate 1

Southern, central and northern highlands, the south-eastern highlands of Ethiopia at 1750–3200m. Areas of heavy rainfall are forested; in areas of moderate rainfall, grassland predominates. November–February generally dry. Temperatures lower than in surrounding lowlands; mean temperature of coldest month <18°C, but for more than four months, mean temperatures >10°C. Lowest temperatures November–February, highest April–May, because summers are very cloudy. Mean annual rainfall usually 900–1500mm, but distribution and amount vary considerably from area to area, thus affecting vegetation.

Warm temperate climate 2

Parts of the south-western and south-eastern highlands of Ethiopia. Suitable for abundant forest cover, as land typically has more soil moisture than previous category. Humid temperate climate; no dry season. Mean temperature of coldest month <18°C. Rainfall adequate in all seasons.

Cool highland climate

Isolated areas of very high land, thus the Bale Mountains, Ankober, mountain areas west of Kombolcha, mountain areas in central Gojam (the Choke Mountains) and north-east of Gonder including the Simien Mountains, at >3500m. Afroalpine vegetation. November–February dry. Temperature of warmest month 10°C or less. Mean annual rainfall 800–2000mm.

Climate change

Ethiopia and Eritrea are likely to be two of the countries in Africa most vulnerable to climate change, which will affect agriculture, water resources, biodiversity and ecosystems and hence the livelihood of the region's peoples. It will also affect the habitats available to the region's birds.

The first impact of climate change will be a rise in temperatures. Mean annual maximum and minimum temperatures have been rising in the region by 0.1°C and 0.25°C per decade respectively (Demissie 2007). This trend is likely to have particularly strong implications in the future for both low-lying areas and the highest rainfall areas. In the lowlands increasing temperatures are already being coupled with more extreme rainfall events, including untimely rainfall, more extreme drought and floods. This will exacerbate water stress and increase desertification. In the highest areas, the afro-montane vegetation and its associated fauna are likely to encroach on the already highly vulnerable afroalpine areas, and flora and fauna species which cannot compete with this encroachment will be threatened with extinction.

Although the amount of rainfall in the region has been more or less constant over the past 50 years, an overall decline has been noted in northern parts of Ethiopia and in Eritrea (Demissie 2007). This chapter has also noted the significance in the region of local variations in rainfall, caused by altitude and by microclimatic variations, created by local relief differences and prevailing winds. Climate change may be expected to lead to many changes in such local microclimatic conditions.

The potential consequences of climate change for the region's natural resource base are likely to be very serious and it will be important to develop local adaptation strategies to mitigate the worst effects.

BIRD HABITATS IN ETHIOPIA AND ERITREA

Introduction

There is as yet no universally accepted system for classifying habitats (Carswell *et al.* 2005). For the purposes of this volume, we have chosen to use vegetation as the primary criterion for defining habitat as, while there are clear exceptions (areas of open water, deserts, some man-made habitats, for example), in almost all habitats plants form the key element. Britton (1980), Lewis & Pomeroy (1989), Carswell *et al.* (2005) and Wondafrash (2007) have all been referred to in the writing of this account.

Environmental factors affecting bird distribution and bird habitats

While most birds depend directly or indirectly on plants, it is an oversimplification to think of bird distribution as being defined simply by vegetation. The entire environment shapes the organisms that occupy it. Old trees are attractive to woodpeckers; landscapes with very few trees provide security of vision for some bustards; thorny trees provide nesting security for Stresemann's Bushcrow, while wells and huts perform similar functions for swallows. In some cases it is possible to be explicit about habitat requirements. For example, we can say that Heuglin's Bustard is restricted to semi-desert plains, Yellow-bellied Hyliota to *Combretum–Terminalia–Hyparrhenia* savanna. However, in each case, it is not primarily the plants or other factors associated with the habitat which are the ultimate factor in determining the bird's distribution and habitat preference, but the insects, seeds, fruits, rodents or other food sources associated with them, and for most species we have no clear idea what these are.

Birds which occur at high altitudes have over millennia adapted to environmental factors such as low nocturnal temperatures, high winds, and low-density oxygen. However, it is not that they necessarily prefer high altitudes, but rather that the plants that occur at such altitudes make suitable food available. Aspects of rainfall such as quantity, seasonality and, crucially in Ethiopia and Eritrea, reliability act in the same way. An example of a species whose distribution appears to reflect rainfall is the Pale Prinia, found exclusively in areas of low rainfall. The unreliability of rainfall and lack of clear dry and wet seasons in lower altitudes of the region, i.e. mostly below 1500m a.s.l., mean that breeding seasons are thought to be less clear-cut than at higher latitudes (Carswell *et al.* 2005). Availability of large bodies of water, their extent, their depth, their type, their chemical make-up, all have impacts on the aquatic bird species associated with them, and changes in any of these may have positive or negative consequences for bird populations. Soil and associated rock types have a strong influence on the distribution of natural vegetation within a given geographical area. Some species, especially larks, have even evolved cryptic plumages which match the dominant shade of the soil. The next most important factor is moisture regime – rainfall as well as access to ground water. For example palm groves flourish around hot springs in the desert and riverine vegetation, attracting Palm Swifts and Red-necked Falcons. All these factors, as well as the influence of man, affect the presence or absence of bird species and they should be borne in mind when considering the following largely vegetation-based description of habitats below.

1. Desert and semi-desert habitats

Extensive areas in the north, east, south-east and south of the region consist of semi-desert and desert, with various types of habitat including dry open sandy and stony plains, sparse grassland with scattered dwarf shrub and tree growth, and rocky hills. Some species typical of habitats in semi-desert areas include Egyptian Vulture, Little Owl, Greater Hoopoe-Lark, Fulvous Babbler, Heuglin's Bustard, Desert Warbler, Desert Lark, Spotted Sandgrouse, Desert Wheatear, Kurdish Wheatear and White-crowned Black Wheatear, although some of these extend into other habitats. Nubian Nightjar and Desert Cisticola occur on the dry coastal plains and *Panicum* steppe in Eritrea, Ostrich and Arabian Bustard in semi-desert areas of the Awash Valley, and, in the Ogaden, Little Brown Bustard, Short-tailed Lark and Somali Sparrow. Very large numbers of Palearctic migrants pass over the relatively foodless desert and semi-desert areas in the north, east, south-east and south of the region on migration.

The northern Danakil desert, northern Ethiopia (John Atkins).

2. Bushland, grassland and savanna habitats

Savanna habitats include all those where the ground flora is mainly composed of perennial grasses and succulents, with a flourishing of short-lived herbs and annual grasses after rains. There is great variation in the woody vegetation, from wide open, rolling or hilly grasslands with very scattered or no woody plants, to savannas with substantial numbers of trees and shrubs, including *Acacia–Commiphora* and *Combretum–Terminalia*, often forming thickets. Savanna habitats which include wooded grasslands, bushlands, tall *Hyparrhenia* grasslands and short-grass plains generally occur in areas of moderate rainfall and at a range of altitudes. The highland grasslands on the plateau, at 1800–2750m, are found in valley bottoms and are the result of the heavy black clay soil preventing the establishment of woody species, because the alternate swelling and cracking of the soil breaks the roots of woody plants.

The 19 Sudan–Guinea savanna biome-restricted species recorded in Ethiopia and nine in Eritrea include several from savanna habitats at lower altitudes in the west, such as Red-pate Cisticola, which occurs sparsley in dry grasslands at low altitudes in SW Ethiopia. Ninety-seven Somali–Masai biome-restricted species are recorded from Ethiopia, including Erard's Lark and Somali Short-toed Lark, which occur in once extensive grasslands within *Acacia–Commiphora* woodland at Negelle, where Pectoral-patch Cisticola is commonly found in rough tussocky grassland and also at higher altitudes on the central plateau; overwintering Pallid and Montagu's Harriers frequent a wide range of highland and mid-level grassland habitats throughout the region; Red-faced Crombec, Emerald-spotted Wood Dove, Great Spotted Cuckoo and Tiny Cisticola all frequent different niches in acacia bush and savanna; Siffling Cisticola inhabits combretaceous savanna, where Red-winged Warbler is found in tall *Hyparrhenia* grassland.

The Ilala Sala plain, Awash National Park, Ethiopia (John Atkins).

3. Woodland habitats

In areas of higher rainfall, the tree canopy becomes more continuous, and wooded grassland, bushland and savanna merge into woodland with a continuous tree canopy covering more than 20% of the land area (Britton 1980). However, there is usually only one tree layer. Typical woodland genera include various species of *Combretum*, *Terminalia*, *Acacia*, *Commiphora*, etc. Woodland trees are not necessarily tall: *Acacia–Commiphora* woodlands have canopies 5–10m high, or lower, and are typically very open, with ground cover dominated by grasses and herbs. *Acacia* woodlands, for example, where undisturbed by man or grazing animals, can have particularly thick, grassy, scrubby or thicket undergrowth, as their thin leaves allow through more light than broadleaved woodland trees. At higher altitudes the

Acacia woodland, southern Rift Valley, Ethiopia (John Atkins).

Acacia woodland usually merges into forest of mixed *Podocarpus*, *Juniperus* and *Olea*. In lusher areas, particularly where there is good underground water and near wetlands, large figs occur.

Yellow-bellied Eremomela and Pearl-spotted Owlet are two of the many resident species that occur in *Acacia* woodland and associated scrubby undergrowth. Striped Kingfisher, Four-banded Sandgrouse, Green-backed Eremomela, Gambaga Flycatcher, Bush Petronia and Black-faced Firefinch are typical of *Combretum–Terminalia* deciduous woodland. Dense thickets in dry thornbush are home to Grey Wren-Warbler. Where woodlands become thicker in lusher areas, forming dense evergreen thickets or merging into forest including gallery woodland, Narina Trogon, Gabar Goshawk and Brown Snake Eagle occur. Huge numbers of Palearctic migrants enter and leave Africa through the *Acacia–Commiphora* woodlands of the central Rift valley and the south-east, relying on the habitats they provide as a rich source of food.

4. Forest habitats

By comparison with woodlands, forest canopies tend to be multi-layered, more closed and continuous, formed by taller trees, often 20–30m high, with the tallest having their crowns above the main canopy. The lower levels of vegetation are heavily shaded (Britton 1980). Typical tree species include *Afrocarpus (Podocarpus) gracilior*, *Cordia africana*, *Ekebergia capensis*, *Croton machrostachyus*, *Juniperus procera*, *Pouteria adolfi-fredericii*, various *Olea* and *Ficus* species. There is often a lower, more open storey of smaller trees and shrubs where 'wild' forest coffee is found. The ground vegetation is often open, with ferns, a variety of specialised herbs including orchids and lianas reaching up into the tree canopy, and often also growing as epiphytes on the trunks and branches of the trees. The forests at very high altitudes tend to have fairly open canopies. Within forests many bird species are restricted substantially to particular strata, with many typically preferring canopy habitats, a few occupying the mid-stratum, others the lower stratum and forest floor.

Broadleaved forest, south-west Ethiopia (John Atkins).

The forests of Ethiopia and Eritrea were categorised earlier (pp. 27–30) as dry evergreen montane forest (on the highland plateau), dry evergreen forests (in Sidamo, Hararghe and Bale), moist evergreen forests (in the south-west) and lowland semi-evergreen *Baphia* forest (in Gambela). The broad range of habitats that exists in this vegetation type is reflected in the diversity of the Afrotropical biome assemblage, which is known to contain 56 bird species in Ethiopia, and 31 in Eritrea. Examples of Afrotropical Highlands biome bird species that occur, although not exclusively, in dry evergreen montane forests of the highland plateau include Black-winged Lovebird, Yellow-fronted Parrot, White-cheeked Turaco, Banded Barbet and Abyssinian Catbird. Prince Ruspoli's Turaco is known from dry evergreen *Juniperus* as well as other forest in Sidamo. Species typical of moist evergreen forest include African Goshawk, African Olive Pigeon, Lemon Dove, Black-billed Wood Dove, Tambourine Dove, Yellow-fronted Parrot, African Emerald Cuckoo, Yellowbill, Scaly-throated Honeyguide, Red-shouldered Cuckooshrike, Yellow-breasted Apalis, Red-capped Robin-Chat and Sharpe's Starling. However, in fact, the avifauna of forests within the region is not particularly rich compared with similar habitats further south in Africa, with several genera, for example bulbuls, being poorly represented.

Evergreen scrub, which occurs where forests have been degraded and as an ecotone with various kinds of woodland, contains important habitats for such species as Singing Cisticola, Cinnamon Bracken Warbler, African Yellow Warbler and Green Twinspot. The only population in the region of the very local Olive-bellied Sunbird, as well as a more widespread population of Yellow-throated Greenbul, occurs in habitats of evergreen scrub in the west and south-west of Ethiopia.

5. Montane habitats

According to Yalden (1983), 50.4% of the land in Africa above 2000m and 79% of the land above 3000m are found in Ethiopia and Eritrea. Thus our area has a much greater area of high ground and a much higher proportion of montane habitats than any other part of Africa. This ranges from *Acacia* savanna, broadleaved woodlands and subtropical humid forests, through *Junipera–Podocarpus* and bamboo forests to, at the highest altitudes, afroalpine and sub-afroalpine heaths and moorlands.

Many bird species are restricted to a greater or lesser extent to montane habitats in the region. Moorland Francolin and Moorland Chat are associated with high-altitude moorlands. Rocky places, cliffs and gorges are attractive to a range of species, including White-collared Pigeon, Mocking Cliff Chat, White-winged Cliff Chat and Rüppell's Black Chat. Ankober Serin is associated with precipitous cliffs and

Moorland on the Sanetti plateau, Bale Mountains National Park, Ethiopia (John Atkins).

adjacent broken hillsides. The wetlands and moorlands of the Sanetti Plateau in Bale Mountains National Park are a breeding location for Spot-breasted Plovers and Wattled Cranes. Bale Mountains hold the world's most southerly breeding populations known of Ruddy Shelducks, Golden Eagles and Red-billed Choughs. Chestnut-naped Francolin, Cape Eagle Owl, Brown Parisoma and White-billed Starling are other species typical of montane habitats. Highland areas are particularly rich in birds of prey, which are attracted to the large number of rodents that live in highland grasses.

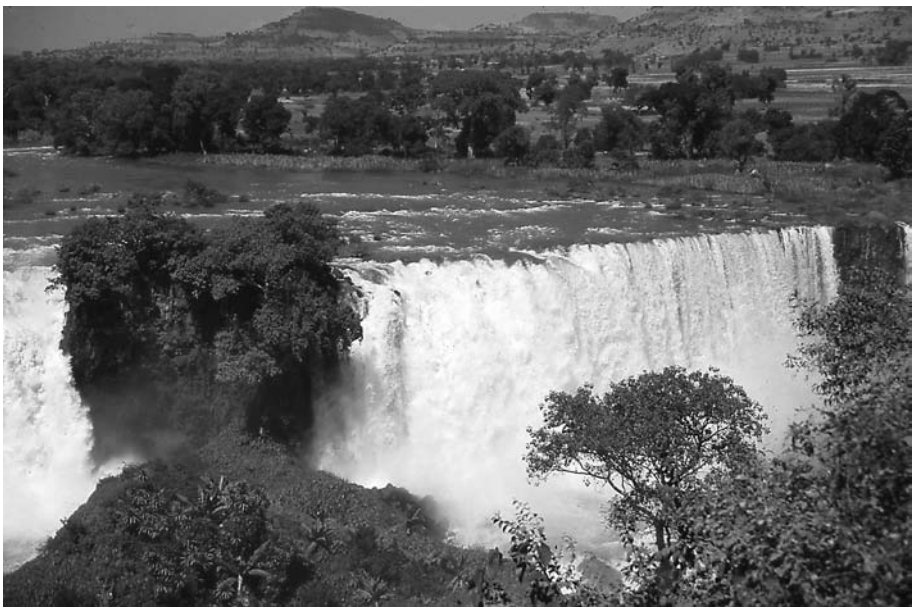
6. Wetlands, larger lakes and rivers, marine habitats

Ethiopia and Eritrea have most, if not all, of the major types of wetland and aquatic habitats, including major and smaller rivers, lakes, swamps, marshes and seasonal ponds and marine habitats, notably islands, sandy beaches, estuaries and mangroves. See Figure 14 for the main wetland areas of the region.

The Eritrean coastline is dominated by sandy beaches, with isolated patches of mangrove and a fringing coral reef in parts. Huge numbers of shorebirds use these coastal areas, and White-collared Kingfisher, Clamorous Reed Warbler and the *avicenniae* race of Eurasian Reed Warbler occur in mangroves, while sand-dunes and salt-flats with scattered *Acacia* bush or *Suaeda* thickets are inhabited by Graceful Prinia and migrant Desert Warbler. The Dahlak Islands are an important breeding area for many seabirds as well as Sooty Falcons.

The various lakes and wetlands in the region differ considerably in size and composition. Some, like Lakes Chamo, Abaya and Awassa, are freshwater. Others, particularly Lakes Abiata and Shalla, are alkaline, mineral-rich lakes, supporting internationally important waterbird populations – especially flamingos, pelicans and wintering ducks and waders from the Palearctic. Chew Bahir is an extensive and important area of saline swamp.

All the major rivers in the region, and thus effectively all waters for Ethiopia and Eritrea, originate in the highlands (EWNHS 1994). Three major Ethiopian rivers do not reach the sea: the Wabe Shabeelle normally disappears in swamps in southern Somalia before reaching the Juba river, the Omo ends in Lake Turkana on the Kenya border, and the Awash disappears into the sand in Lake Abbé on the Djibouti border. Other rivers of importance are the Abay (Blue Nile) and Tacazze in the north and the Genale and Dawa in the south-east. The Awash



The Abay (Blue Nile) River at Tississat Falls, near Bahar Dar, Ethiopia (John Atkins).

Filwoha hot springs, Awash National Park, Ethiopia (John Atkins).

river, which originates in the highlands north of Addis Ababa, is the only major river that rises and ends within Ethiopia. Eritrea has only one perennial river, the Setit/Tacazze, which rises in the highlands near Lake Tana in Ethiopia and forms the border between Ethiopia and Eritrea before flowing into the Atbara river in the Sudan. Highland forests have the important function of protecting water sources for these rivers, thus providing a steady year-round flow of ground water to lower, drier areas and helping to stabilise local climatic patterns. A wide range of bird species is associated with rivers and riverine vegetation; those in riparian woodland include Bruce's Green Pigeon, Brown Parrot and Pel's Fishing Owl. Increasingly riverine vegetation is coming under threat throughout the region.

The bottoms of highland valleys contain permanent swamps, temporary marshes and edaphic grasslands, which serve as important grazing areas for domestic animals. However, in many areas of the region, for example around Lake Tana and in the west and south-west, swamps and marshes are being increasingly exploited for agricultural purposes. Throughout the region swamps and marshes feed into larger river systems and thereby play a part in providing water for other parts of the region. Swamp and marsh wetlands, both permanent and temporary, throughout the region provide important habitats for a huge variety of plants and bird species. Those in the highlands include various whydahs and widowbirds, Wattled Ibis, Blue-winged Goose, Wattled Crane, Rouget's Rail, White-winged Flufftail and Abyssinian Longclaw. At lower levels swamps and marshy areas with long grass and reedbeds attract a range of species including White-browed Coucal, Blue-headed Coucal, Croaking Cisticola and Lesser Swamp Warbler. In the south-west, damp grasslands and evergreen scrub on the periphery of marshes attract African Yellow Warbler.

Large areas of the north-west and north-east of Ethiopia and Eritrea, the highlands and lowlands of eastern Ethiopia and the south-eastern lowlands of the Ogaden and Hararghe have relatively few sources of water. Water Dikkop, African White-winged Dove and Juba Weaver are three species restricted to the major rivers of the south-east, the Wabe Shabeelle and the Weyb–Genale–Dawa system, which becomes the Juba. The Juba and Shabeelle valleys are designated as an Endemic Bird Area, providing specialised habitats for the latter two species.

In the western lowlands around Gambela, there are extensive seasonally flooded grasslands, caused at least partly by water feeding down from the highlands. Here long grass among bushes and lush scrubby areas along riverbanks and marshes attract species such as Foxy Cisticola.

7. Man-made habitats and habitat change

Here we can differentiate between man-made habitats, including urban development, roads, and associated power and telegraph lines, bridges and culverts, and habitats created by cultivation.

Urban habitats, especially house and hotel gardens and parks, are usually extremely rich in bird species. Gardens and hotel grounds often contain artificial pockets of scrub, thicket and indigenous trees, which are attractive to a surprisingly wide range of species. Such habitats in Addis Ababa support endemics such as Rouget's Rail, Black-winged Lovebird, Abyssinian Catbird, Banded Barbet and Gold-mantled Woodpecker, all of which breed within the city. Even areas entirely devoid of vegetation, such as city apartment blocks, are popular for roosting and nesting. Roadside trees, poles and wires provide convenient vantage points for species such as Long-crested Eagle, Black-breasted Snake Eagle, bee-eaters and rollers; bridges attract species such as White-rumped Swift; and in rural areas culverts are used for nesting by Red-chested Swallow. Ethiopian Swallows breed in huts in southern Ethiopia and White-tailed Swallows are believed to do so too (Holtam 1998). The House Sparrow has spread across Eritrea from Sudan to the Red Sea, mainly along major roads. A special case, particularly in rural areas on the highland plateau, is that of Orthodox church compounds, where relict patches of natural vegetation, particularly woody species, are protected and provide habitats for a range of highland species.

The term cultivated habitats can be used to designate a wide range of habitats from areas of intensive cultivation to plantations of *Eucalyptus*. With rising populations and population movements, more and more areas are being cultivated, resulting in a dramatic decline

in natural vegetation throughout the region and this is continuing. All the vegetation types described in the previous section have been modified by man over time. Opening up land for agriculture or other purposes such as wood and charcoal-selling not only involves forest and woodland clearance but also increases the incidence of fire. Intensive grazing by domestic animals results in diminishing grass and other ground cover and reduces the chance for indigenous seedlings to survive. Opening up of roads into new areas leads to settlements and reduction of forest cover. All these modifications are likely to be causing a decline in numbers and diversity of birds.

The present unlicensed cutting of trees for fuelwood and charcoal is likely to be having very substantial impacts on species such as hornbills, lovebirds, barbets and wood-hoopoes, all of which nest in holes in large trees. On the other hand some species, including Laughing Dove and Speckled Pigeon, have undoubtedly benefited from the opening up of cultivated land and associated villages and small towns.

Increasingly, indigenous trees are being replaced by exotics. Exotic plantations are favoured by few bird species, although some, including Dusky Turtle Dove, African Hobby, Rufous-breasted Sparrowhawk and Great Sparrowhawk, roost and/or nest in them, and Black-winged Lovebird has become adept at feeding on the unripened cones of Mexican Cypress, *Cupressus lusitanica*.

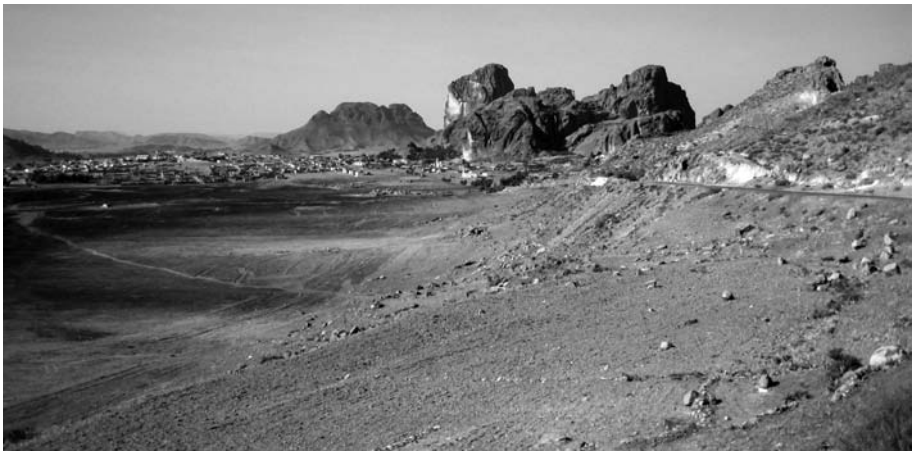
The role that wetlands play in the livelihoods of people of the region has been taken for granted and modifications that threaten wetland habitats are evident everywhere. Many highland wetland areas are susceptible to drying up due to excessive pressure on forest areas for agricultural and grazing land. This may be having a negative impact on populations of species such as Rouget's Rail and Blue-winged Goose. In the highlands of western and south-western Ethiopia, wetlands are also being over-exploited in efforts to promote food sustainability, to support the increasing human population from settlements in those areas.

The Rift Valley lakes are vulnerable to a range of human activities around them, including irrigated farming activities next to Lake Zwai and the soda ash factory near Lake Abiata. The size of Lake Zwai is diminishing at an alarming rate due to diversion of water flowing into the lake for small- and large-scale irrigated farming, horticulture and floriculture. Lake Abiata, nominated as a possible Ramsar site, is under huge pressure from a range of threats, the most serious of which are establishment of settlements, siltation as a result of deforestation, degradation of watersheds and agricultural activities, overgrazing by livestock, unsustainable fishing, extraction of mineral salts, as well as commercial extraction of sand for construction and of soda ash (Wondafrash 2007). Thirty years ago Lake Shalla held a breeding population of up to 12,000 pairs of White Pelican, which used nearby Lake Abiata to feed. Since then, Lake Abiata has become shallower, there is decreased inflow from Lake Zwai, the chemical balance of the lake may have been altered by the soda ash project, and the fish population has substantially declined. Few pelicans now breed at Lake Shalla and feed at Lake Abiata, although it is still not clear which variables have determined this reduction. Lesser Flamingos, which have in earlier years built nests at Lake Abiata, apparently did manage to breed successfully there in 2006, when there was a large crèche of young at Abiata in mid-October among thousands of adults. Threats to nearby Lake Langano include clearance of surrounding woodland, overfishing and extraction of sand.

The Awash river is dammed at Koka to provide hydro-electric power for Addis Ababa and other urban centres in the Rift Valley. It is also used lower down for irrigation purposes, for fruit-growing (Merti), sugar production (Metehara), and cotton-growing (Tendaho). The whole area is increasingly vulnerable to pollution from activities at Metehara, Merti and Tendaho. In common with many other wetlands Koka Dam is suffering severely from siltation due to increased run-off of soils caused by the destruction of vegetation in the highlands and absence of effective soil conservation measures there. However, while these modifications have reduced indigenous cover and have led to increased pollution, they have also created new habitats attractive to a wide range of species.

Lake Ashange, Borkena wetland, Gudo flood plain, Berga wetland, Lake Arakit and Boyo swamp are all under pressure from intensive grazing. The vegetation surrounding Lake Aranguade (Green Lake) and Lake Chitu has been totally cleared, which may affect the number of flamingos they can support. The Akaki wetlands are heavily polluted by waste from Addis Ababa. Lakes Awassa, Ardibo and Hayk, Koka Dam and Chelekleka wetland face threats from intensive agricultural activities at the edge of the wetlands, causing siltation and damaging reedbeds that are important breeding habitats (Wondafrash 2007). Lake Alemaya has almost disappeared.

Habitat change is a natural ongoing process, but the future for birds in Ethiopia and Eritrea now depends very substantially on man. Population growth looks set to put increasingly severe pressure on the environment and, as the impact of man increases, unless good conservation practices are speedily adopted, many habitats will decline perilously in species richness. An important purpose of our atlas is therefore to document bird distribution in a particular period, in order to provide a baseline against which the effects of future habitat changes can be assessed.



Barren agricultural plains near Senafe, Eritrea, at 2400m (Jason Anderson).

BIRD AND WILDLIFE CONSERVATION IN ETHIOPIA AND ERITREA

John Atkins and Chris Hillman

Introduction

The following account of the history of wildlife conservation in the region, current issues limiting implementation of effective conservation practices, the ornithological significance of the region, and current efforts to determine the status of birds in the region and to conserve them is based on a number of sources, particularly Hillman (1993a,b), Tilahun *et al.* (1996), Wondafrash (2002, 2007) and Fishpool & Evans (2001). In addition the following have been referred to: Ash (1972a), Yalden (1983), Collar & Stuart (1985), Collar *et al.* (1994), IUCN (1994), Tedla (1995), Stattersfield & Capper (2000), Stattersfield *et al.* (1998) and EWNHS (2002, 2007). Figure 15 illustrates the protected areas in the region, while Endemic and Important Bird Areas are indicated in Figure 16.

A brief history of wildlife conservation in Ethiopia and Eritrea

Information on the quality and quantity of the wildlife resources in Ethiopia and Eritrea in the past is scarce. In the highland blocks on each side of the Rift Valley relatively stable agrarian cultures became established over 5000 years ago, especially in the north, around Axum. It is possible that most of the larger species of wildlife in the highlands were considerably reduced or even exterminated early on, because they were in competition with cultivation and livestock raising. These highland areas, though extensively modified by man and densely settled, still represent large areas of unique ecological conditions. Yalden (1983) estimated that over 80% of the land in Africa at an altitude of over 3000m a.s.l. occurs in the Ethiopian highland massifs in extensive plateaus, and postulated that this may be why so many endemic animals and plants are found in Ethiopia and Eritrea. Smaller isolated mountain peaks are found elsewhere in Africa. The wildlife on the Ethiopian plateaus has adapted to very different conditions from the surrounding areas. The result is a rich diversity of endemic plants, mammals, birds and amphibians.

The lowland peoples are pastoralists and hunter-gatherers, depending on extensive livestock herds and the use of wildlife for their livelihoods. These cultures came into less conflict with wildlife, were not permanently settled (because of shifting patterns in rainfall and resources) and existed at a much lower population density than did the highland cultivators. As a result, far more wildlife survived in these drier and less productive areas.

On 5 Tekempt 1901, Ethiopian Calendar (16 October 1909 Gregorian Calendar), Emperor Menelik II passed the first legislative protection of wildlife, a proclamation to regulate hunting, especially of elephant. During the Italian occupation (1936–1941) various attempts at wildlife conservation, primarily aimed at game mammal species, were introduced (Petrides 1961). These included the delimitation of various wildlife conservation areas, including Handa and Let Marefia (Wof Washa). The Italian occupation also saw the compilation and publication of four volumes on the birds of Italian Africa by Edgardo Moltoni and Giuseppe Gnecchi Ruscone, and important bird collections by Toschi and Patrizi. In 1944, the Preservation of Game Proclamation Laws were passed, regulating various aspects of the hunting of animal wildlife species. The present Awash National Park was, at this time, an Imperial Hunting Ground and the numbers of animals in the park had been greatly reduced. In 1959, the British administration in Eritrea gazetted Gash-Setit, Yob and Nakfa Wildlife Reserves and they became part of the wildlife conservation areas system developed for Ethiopia in the late 1960s. However, in present-day Eritrea they no longer represent viable conservation areas and attempts are in hand to identify other areas of significance for wildlife conservation and management.

Interest by the rest of the world, and by non-governmental conservation organisations, began in the 1960s. In 1961, Dr George Petrides, sponsored by the New York Zoological Society and the US-based Conservation Foundation, recommended the establishment of protected areas for the larger mammalian wildlife of the country. The UNESCO Mission of 1963, headed by Sir Julian Huxley, proposed the creation of a Conservation Board responsible for the conservation and development of natural resources; a Conservation Bureau to establish national parks and other conservation areas; the establishment of a system of national parks and controlled hunting areas, and measures to protect Ethiopia's rare large wild mammals. The first Adviser and Senior Game Warden of Ethiopia, John Blower, was appointed in 1965 to act on these recommendations. A Wildlife Department was established which soon became the Ethiopian Wildlife Conservation Organization (EWCO).

Subsequently expeditions and extensive fieldwork were sponsored by the Wildlife Department, and were carried out by Leslie Brown, Melvin Bolton and J. G. Stephenson. During the 1960s and 1970s expatriate wardens were employed in the earliest national parks to be established (Peter Hay and David Anstey in Awash, Clive Nicol in Simien, George Brown in Omo and John Bromley in Eritrea). The US Peace Corps provided young volunteers for several of these areas in the late 1960s and these people carried out inventory work in the proposed wildlife conservation areas. Other contributions in this period came from Swiss scientists in the Simien Mountains National Park (including Hans Hurni and Bernard Nievergelt) and Japanese scientists in the Omo National Park (including A. Mizuno and N. Fujioka).

This period was followed by the return to Ethiopia of the first batches of Ethiopian trainees from the College of African Wildlife Management, at Mweka, Tanzania. These formed the core of the Ethiopian Wildlife Conservation Organisation (EWCO), working as assistant wardens, then wardens, before taking managerial positions at the Addis Ababa headquarters. Ethiopian nationals trained in wildlife management have provided the staff of EWCO ever since. From these simple beginnings were laid the foundations of the wildlife conservation system that exists today (see Figure 15). Currently wildlife conservation areas in Ethiopia consist of nine national parks (only two of which are gazetted), 11 wildlife sanctuaries and wildlife reserves and 17 controlled hunting areas. A number of these were quite extensively developed during the 1970s and 1980s with management plans prepared for Awash, Simien, Bale and the Rift Valley Lakes, and improvements made to the facilities for park staff and visitors (Hillman 1993).

However, little was done to develop meaningful dialogue with the local people, or for them to gain any benefit from development in their areas. During 1991–1992 the government was ineffective and local communities expressed their frustration at not being properly consulted

and involved in the formation or development of wildlife protected areas. This led to much destruction of both property and wildlife. Local people moved into and settled in many of the protected areas. Two examples will illustrate the problem.

The Abiata–Shalla Lakes National Park and its surrounding area have been devastated by extensive tree-felling for the production of charcoal, which has become the main source of livelihood for many communities residing in or adjacent to the park. The park's proximity to a major highway, providing easy access to central Rift Valley towns as well as to Addis Ababa, facilitates the destructive process. People have settled in the park, growing maize, keeping livestock, over-exploiting the fish resources and collecting the very salty sand from the shore of Lake Abiata to sell as salt lick. Deforestation, overgrazing by livestock and cultivation of the fragile alluvial soils are leading to severe wind erosion and desertification.

Awash National Park has in the past 10 years been substantially occupied by pastoralists. Tedla (1995) estimated that over 50% of the park area had been occupied. Tree-felling for construction and charcoal has become common, and is exacerbated by the main Addis Ababa–Djibouti road passing through the park. Fires are commoner than in the past, with charcoal burners and pastoralists being blamed for most of them. The pastoralists see no benefit to them from the park's existence and claim it limits their access to the Awash river for watering their cattle. They also contrast the lack of benefits from the park with their gains from the nearby Metahara Sugar Estate, which provides employment, land for cultivation and access to water.

Outside protected areas, too, population pressures have impacted on the environment in many areas of the region. One example has been the Ethiopian government's resettlement programme, initiated in 1984, aimed at moving about two million people from the 1984–85 famine area in the northern highlands to less populated and undeveloped areas in the west and south-west of Ethiopia. Considerable damage to forests and wetlands resulted from the initial movement of the first 600,000 highlanders. Major threats to wetlands are considered in the chapter on 'Bird habitats'.

The above examples highlight the scale of the problem being experienced throughout the region, as populations and demands on scarce natural resources increase. Biodiversity is under threat from all directions: population pressure, overgrazing by increasing livestock populations, urbanisation, road-building, expansion of agricultural land particularly for 'modern' estate-style farming and resultant reduction of grasslands, accelerating land degradation, desertification, deforestation, reclamation of mudflats, drainage and cultivation of wetlands, and invasion by alien species. Bird and mammal habitats are under threat and key sites holding globally endangered species are being steadily destroyed. Much of the region's fauna is threatened and may eventually become extinct. These pressures, combined with economic difficulties, especially falling agricultural product prices, and unreliable natural ecological processes, particularly erratic rainfall, mean the region is in dire need of sound natural resources management.

The concept of wildlife conservation as an activity carried out in national parks and conservation areas, devoid of human activities except those of management and visitors, is now generally agreed to be inappropriate, but that does not mean wildlife and environmental conservation is an unaffordable luxury. The Ethiopian Orthodox Church, Islam and the more animist traditions of the Oromo peoples have long instilled a basic respect for wildlife, and rural communities have clear perceptions of the relationship between the health of the resources around them and their own survival, although this appreciation is sadly being lost in urban centres. There is an urgent need to integrate environmental conservation with sustainable utilisation of the environment in the whole region, through the coordination of education, population control, land use and development activities.

In Ethiopia a comprehensive Conservation Strategy was developed after 1993 and is providing the basis for the country's environmental policy. Central to both its development and implementation is the full participation of the people of Ethiopia, from local communities through development agents to senior policy makers and managers, in the implementation of the policy. This goes alongside the government's firm commitment to decentralisation of political and administrative functions. For wildlife, it has meant handing over the management of official protected areas to their respective regional governments, with EWCO retaining the mandate to coordinate policy and research, guide manpower development and generally act as a source of expertise and advice for the regions. EWCO has always been a unit in the natural resources department of the Ministry of Agriculture and Rural Development, but a new management structure being developed may change this. The Institute of Biodiversity is developing a unit for wildlife conservation. These are still relatively new developments and there is much to be learned at all levels. However, remembering the backlash from the local people when centralised 'protection' was removed in 1991 and 1992, a system which properly involves both the local administration and local communities needs time and support to develop. Constraints that currently limit implementation of effective conservation practices include inadequate funding, difficulties in coordinating conservation activities between government agencies, difficulties in implementing effective forest management, lack of data, limited awareness of environmental issues and the low level of participation in sustainable environmental activities at grass-roots level. The government is moving in the direction of opening up wildlife conservation in protected areas to private management. This is bringing new challenges. Ethiopia and Eritrea have developed strong population policy documents, but it will be at least two generations before a reduction in the birth rate can start to have an overall effect on the rate of its increase.

Eritrea has developed along its own lines since its independence from Ethiopia in 1993. The country inherited no wildlife conservation infrastructure and little wildlife information from the previous regime, apart from the 'paper parks' of the Dahlak Archipelago and the gazetted but non-existent 'wildlife reserves' of Yob, Nakfa and Gash-Setit. Eritrea is now developing its own environmental policy, conservation infrastructure and system of protected areas. Currently there are no formally protected areas as legislation has not yet been developed, while the potential of various sites for protection is still under consideration. A Forestry and Wildlife Division has been established within the Ministry of Agriculture, and has been actively involved in the inventory of species and habitats over the whole country. Marine resources, including marine birds, are being inventoried by the Ministry of Fisheries. The Ministry of Land, Water and Environment is developing environmental policy. A National Environmental Management Plan (Eritrean Agency for the Environment 1995) outlines threats to wildlife, proposes a strategy for conservation of biodiversity, including the creation of a protected area system, the formulation of conservation legislation, and states the requirements for education, awareness-raising, training and local participation. A National Biodiversity Strategy and Action Plan was produced in 2000 (Department of Environment, Ministry of Land, Water and Environment 2000) and a survey of proposed protected areas and biodiversity conservation corridors was produced in 2006 by the Ministry of Agriculture (Yohannes and Bein 2006).

It is unclear which agency will be responsible for designating protected areas in future, although as many as 27 sites have already been proposed. Priority conservation status has been proposed for Semenawi Bahri, Buri Peninsula, Gash–Setit, Yob and the Dahlak Islands, and it is likely that other areas, including riverine habitats along the Gash and Barka rivers, will achieve protection too. Conservation and wildlife legislation, increased staffing levels and human resource capacity-building in relevant departments, particularly at regional level, are all essential if wildlife conservation is to develop effectively in Eritrea.

Ornithological importance of the region

Ethiopia and Eritrea have a rich avifauna (872 species) representing 39% of Africa's bird species. Of these, 490 are known to breed in Ethiopia and 206 in Eritrea. A minimum of 200 are certain Palearctic migrants to Ethiopia and/or Eritrea, while a minimum of 89 are known to be Afrotropical migrants, nine of which are also Palearctic migrants. Ethiopia has 18 endemic bird species restricted to its geographical boundaries and shares another 14 with Eritrea, thus making a regional total of 32 species (see List E).

The status of Critically Endangered, Endangered, Vulnerable or Near-threatened has been given to species of global conservation concern which are considered to be threatened with extinction (IUCN 1994). A total of 2 Critically Endangered, 7 Endangered, 14 Vulnerable and 21 Near-threatened species have been recorded in Ethiopia, while 3 Critically Endangered, 3 Endangered, 6 Vulnerable and 16 Near-threatened species are known from Eritrea (see Appendix 2).

The Important Bird Areas (IBA) programme of BirdLife International aims to identify sites of international importance for birds. So far 69 IBAs have been identified in Ethiopia and 14 in Eritrea (Tilahun *et al.* 1996, Fishpool & Evans 2001) (See Appendix 1). To qualify as an IBA, a site must meet at least one of four categories: it should hold significant numbers of globally threatened species, or other species of global conservation concern (see Appendix 2); it should support a significant percentage of the population of two or more species whose breeding distributions define an Endemic Bird Area or Secondary Area (see below); it should hold a significant component of a group of species whose distributions are largely or wholly confined to one biome (see Appendix 4); it should support large congregations, usually more than 1% of the worldwide population, of one or more particular species, whether breeding, roosting or on migration.

Three Endemic Bird Areas (EBAs) are recognised in Ethiopia (Stattersfield *et al*. 1998) (Figure 16). EBAs are areas where two or more species of restricted range occur together in breeding populations. Restricted-range species are defined as species with world distributions of less than 50,000km^2. In our region the EBAs are the Central Highlands, the South Ethiopian Highlands, and the Juba and Shabeelle Valleys. Of these, the Central Highlands extends into Eritrea, while the Juba and Shabeelle Valleys EBA is shared with Somalia. In addition one Secondary Area (an area supporting one or more restricted-range species, but not qualifying as an EBA because fewer than two species are entirely confined to it) is recognised in the area of Awash National Park. In all, 12 restricted-range species occur in Ethiopia within these three Endemic Bird Areas and one Secondary Area. Four species are restricted to the Central Highlands, one of which occurs in Eritrea, five to the South Ethiopian Highlands, two are characteristic of the Juba and Wabe Shabeelle Valleys, while one species has a limited distribution in the area of Awash National Park (see Appendix 3 for species).

Five major biomes, major ecological communities characterised by distinctive life forms and principal plant species (Tilahun *et al*. 1996), are recognised in Ethiopia and Eritrea. These are the Afrotropical Highlands, Somali–Masai, Sudan and Guinea, Saharo–Sindian and Sahel Biomes. Each has its own biome-restricted assemblage of bird species. Of the Afrotropical Highland biome-restricted species, 56 are known from Ethiopia and 31 from Eritrea; 97 Somali–Masai species occur in Ethiopia, 15 in Eritrea; 19 Sudan-Guinea species are known from Ethiopia, nine from Eritrea; nine Saharo–Sindian species occur in Ethiopia and 11 in Eritrea; six Sahel species are recorded from Ethiopia, eight from Eritrea. The richest assemblage of Highland biome species occurs in the Bale Mountains; high concentrations of Somali–Masai biome species occur in southern and south-eastern Ethiopia; the lowlands of western Ethiopia hold concentrations of Sudan–Guinea species, while the lowland desert and semi-desert areas of northern Ethiopia and Eritrea are suitable for Sahel and Saharo–Sindian species (see Appendix 4).

The region's diverse habitats also attract large numbers of Palearctic migrants, notably warblers, raptors and waterbirds, mostly on spring and autumnal passage, but also with many species overwintering. There are large concentrations of breeding and wintering seabirds on the Dahlak archipelago, other islands in the Red Sea, and coastal areas. There are significant concentrations of waterbirds in the Rift Valley lakes area and also along major rivers such as the Awash, Omo and Baro, and along the Red Sea coastline. Over 130 wetland congregatory species are recorded. These are species held to be vulnerable by concentrating at valuable or sensitive sites when breeding, overwintering or on passage.

The distribution map scheme

To record distributional data on birds in such a large area, a reliable system was necessary. In 1969 John Ash of the Medical Ecology branch of NAMRU-5 developed a simple and uniform system for recording biological phenomena (Ash 1972). Originally designed for recording distributional data concerning diseases, their vectors and agents, with the aim of identifying possible reservoir hosts for viruses that might affect humans, this mapping scheme enabled systematic collation and analysis of existing material on birds and prepared the way for the collection and analysis of huge amounts of new data on the birds of Ethiopia and Eritrea after 1969. This mapping scheme forms the basis of the present atlas, which determines the status of all bird species in the region.

Bird conservation activities in Ethiopia

Prior to 1995 almost all research on birds in the region, with the important exceptions of that undertaken by Yilma Dellelegn Abebe and Tesfaye Hundessa, had been carried out by foreigners. In 1995 the Ethiopian Wildlife and Natural History Society (EWNHS) commenced a collaboration with BirdLife International and the Ethiopian Wildlife Conservation Organisation, to implement the Important Bird Areas (IBA) programme, which aims to identify, document and protect a network of sites critical for the long-term conservation of birds and other biodiversity. Since 1995, led by IBA project leader Mengistu Wondafrash and supported by Yilma Dellelegn Abebe, Mirhet Ewnetu, Anteneh Shimelis and others, the society has been involved in a range of bird conservation activities.