VULTURES

Their Evolution, Ecology and Conservation

Michael O'Neal Campbell

CRC Press
Taylor & Francis Group
A SCIENCE PUBLISHERS BOOK

VULTURES

Their Evolution, Ecology and Conservation

This page intentionally left blank

VULTURES

Their Evolution, Ecology and Conservation

Michael O'Neal Campbell
Simon Fraser University
British Columbia, Canada

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business
A SCIENCE PUBLISHERS BOOK

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Version Date: 20150611

International Standard Book Number-13: 978-1-4822-2362-0 (eBook - PDF)

Visit the Taylor & Francis Web site at
http://www.taylorandfrancis.com

and the CRC Press Web site at
http://www.crcpress.com

Preface

In current times, a science project, far from being a rudimentary exercise in laboratory methods techniques, is an acute business of timely investigations, popular and/or adequately promoted unpopular positions, political lobbying and replicable experiments that in concert may gain traction. In other words, the project must catch the big wave, ride it and keep it going. Fundamental questions for any scientific endeavour are: 'Why is this important?' 'Are you sure?' and finally 'So what?'

Vultures are a group of birds that have been at least until recently been relatively ignored by scientists. The question is why should we study vultures? And what would be the relevance of our results? Are vultures relics from the past, irrelevant in the modern context of glass, concrete, highways, farms and small, rare mammals, destined for extinction with their former food, the huge mammals of the Pleistocene? Do they still serve any useful function, considering modern sanitary and landscape management may make their role in cleaning the environment redundant? Considering the historical fascination, quasi-religious and spiritual status, criminal association, repugnance and awe vultures elicit, do we even know enough about them, to assess what we will be missing when they are gone? Finally, what is a vulture—just any scavenging bird with a bald head?

Five key, incomplete components have emerged in current studies of vultures: (1) changing evidence, based on new, chemical and biochemical techniques, has waded into the already murky knowledge concerning the differences between the so called *New World* and *Old World* vultures; (2) vultures are variably susceptible to particular chemicals and many species have gone from being among the commonest birds of prey in the world to critically endangered species; (3) local vulture extinctions have serious negative consequences for both people and animals, in ways not foreseen; (4) captive breeding, unexpectedly can rescue nearly extinct species; and consequently (5) it is quite evident that we know so little about the background of vultures and their ecological importance, that the study of vulture is necessary.

The book searches current knowledge of all the vulture species, using literature sources covering the biology, ecology, evolutionary history, cultural appraisal and current conservation status of both *New World* and *Old World* vultures. It examines recent developments in knowledge on the classification of these two groups, and assesses the importance of these changes. The book differs from older texts by creating ecological and conservation possibility networks around vulture species, examining their relations with other species, including avian competitors (eagles, storks and hawks), mammalian competitors (hyenas, felids and canids), disease-causing agents (that have recently seriously decimated vulture populations in Eurasia and Africa) and environmental change (deforestation, desertification, urbanization, agricultural intensification, hunting and public attitudes).

While these issues have been mentioned in earlier literature, and are scattered among many journal articles, there is insufficient information available on the overall scenario for all the vulture species, comparisons of different factors of vulture extinction and hence the socio-environmental networks within which these variables are embedded. In-depth attention is paid to the trends of these networks, in relation to the evolution, resilience, vulnerability and ecology for the future of vulture species, and to the necessary ameliorative actions. Throughout the book, as many references to relevant literature sources are cited as possible, to allow the reader to use this volume as a source for further reading and a guide to further studies.

The book is divided into three parts. Part 1 (Vulture Classification, Genetics and Ecology) introduces the reader to the ecology and forms of the vultures. Topics include anatomy, scavenging and predation. Three chapters examine in a systematic mode, the eight species of Griffon vultures of the Genus Gyps, the eight species of other *Old World* vultures and the seven species of *New World* vultures. Griffons are given their own chapter, as their genus comprises half of the *Old World* vultures and they have traits absent in the other species. This part may be used for field identification and study, and also serve as a background to the scientific analysis of vulture evolution, ecology and geography in the later chapters. Where the scientific name of the species is first mentioned, the naming authority (i.e., the person(s) who gave the animal its scientific name) is placed after the scientific name. For example, the Turkey Vulture's scientific name is *Cathartes aura* (Linnaeus 1758). Here *Cathartes* is the generic name or the name of the Genus to which the bird belongs. *Aura* is the species name. Linnaeus is the name of the person who gave the bird its classification, in 1958. The same would apply to the Griffon vulture, Gyps fulvus (Hablizl 1783). The name Linnaeus, which is a common name for classification, is usually shortened to L.

Part 2 (Vulture Evolution and Ecology) starts with an introduction that briefly describes the prehistoric evolution of animal species and land cover change and how this affects vulture ancestors and current species. After this there are three chapters. Chapter 4 deals with the biological evolution of vultures. This chapter illustrates the evolution of the New and Old World vultures, their close relations among other species of birds (the storks and raptors), the species they fed on (other mammals and birds) and the land cover of the Earth. It also describes the different systems used for the classification of vultures; bone structure, other body features and DNA. This provides the background for Chapter 5, which looks at the relationship between modern vultures and other species, i.e., mammal and bird scavengers and predators, and Chapter 6, which looks at the climatic relations and landscape ecology of modern vultures.

Part 3 (Vulture Ecology and Conservation) describes the human attitudes and actions, including mysticism, preservation, conservation, extermination, urbanization, agricultural development and industrialization. This is followed by four chapters. Chapter 7 looks at Vultures, Cultural Landscapes and Environmental Change, concerning the impacts of urbanization, agriculture and human hunting practices on vulture populations. These events have had devastating effects on vulture ecology and biogeography, both positively (e.g., food supply increases in urban areas) and negatively (e.g., killing of the animals that provide food, and direct killing of vultures). Chapter 8 looks at a crucial aspect of this engagement; the pollutants and diseases that have ravaged the vulture populations in Asia and Africa, these effects being so important as to merit a separate chapter. Vultures formerly considered among the commonest raptors or large birds in some regions are now severely threatened, sometimes with local extinction. Solutions to such problems depend on social, economic and political factors, these largely depend on the social attitude towards vultures in both the local context, and among the international financial actors who may fund conservation and protection schemes. For this reason, Chapter 9 examines public attitudes and conservation policies related to both New and Old World vultures, through history, as historical views, both positive and negative are variably embedded in current attitudes to vultures in many parts of the world, and as such must be examined as a component of both current and future scenarios for vultures. Finally, Chapter 10 looks at the future of vultures. This future is assessed, using all the information presented in the preceding chapters, as vulture survival and wellbeing will depend on their biological and ecological resilience, their relations with other animals and environmental dynamics and ultimately, the will of humans.

This page intentionally left blank

Contents

This page intentionally left blank

PART 1

Vulture Classification, Genetics and Ecology

This part comprises three chapters that give a detailed summary of the seven species of New World vultures and the sixteen species of Old World vultures. The New World vultures are now found only in the New World, and Old World vultures are found only in the Old World. However, this was not always so; if we were classifying these birds to include prehistoric ancestors it would be better to describe the New World vultures as Cathartid vultures and the Old World vultures as Accipitrid vultures. Part 2 of this book will examine the location of ancestral fossils. As will be discussed in detail in later chapters, the main differences between the two groups are that Old World vultures are more similar to the Accipitrid raptors (hawks and eagles), because they have stronger, more raptor-like bills, feet and talons than the New World vultures. For these reasons, the balance of debate is shifting towards two positions, i.e., either the Old World vultures are related to hawks and eagles and New World vultures are more distantly related to these species, or Old World vultures remain related to the hawks and eagles, and the New World vultures are placed with or near the stork family. Further complications arise, because among the Old World vultures, different species appear to have different links with other raptors. Some authorities consequently speculate on the possibility that these vulture species emerged from similar lifestyles among different raptor species and eventually attained similar appearances and habits. This is termed convergent evolution. Considering the differences between New and Old World vultures, 'vulture is an ecologically but not a systematically meaningful term' (Wink and Sauer-Gürth 2004; see also Wink 1995 and Storch et al. 2001). However, before we start with the issues and systematics of these species, it is necessary to elaborate on some terms and phenomena that are basic for the understanding of a vulture's lifestyle, such as definitions of scavengers and scavenging, and the chemical bases of scavenging such as putrification.

Scavenging is a behavior practiced by animals classified as scavengers, predators and omnivores. Therefore, the terms "scavenger" and "scavenging" are not easily defined. Most predatory vertebrates also scavenge on dead flesh they did not kill themselves. This behavior may influence the evolution of scavenging behavior in vertebrates (DeVault et al. 2003). However, among vertebrates, only the 23 species of New and Old World vultures have been described as obligate or permanent full-time scavengers (Ruxton and Houston 2004; Ogada et al. 2011). Their bodies are designed for scavenging and they require this lifestyle for their survival. Physical adaptations for this activity include: bare skin or down covered heads and sometimes necks (with the exception of only the Bearded vulture and Palm-nut vulture), facilitating the thrusting of heads and necks into meat, while avoiding matted blood covered feathers; feet adapted to walking on the ground, rather than grasping prey; and large wings designed for soaring rather than pursuing the prey. Other avian scavengers, such as gulls, corvids, eagles and storks are more suited than vultures to alternate carnivorous or herbivorous lifestyles. Hence, when these species forage for carrion they are called facultative scavengers or temporary, part-time scavengers. An introduction to the ecology of avian scavengers is therefore a complex exercise, including species that compete with, evolve into, or may be mistaken for scavengers.

One definition is that a scavenger is 'an animal (such as a vulture or coyote) that eats carcasses abandoned by predators, digs through trash cans for food, etc., true scavengers seldom kill their own prey (but many animals are not exclusively scavengers)' (Biology Online 2013). Another definition is that a scavenger is either 'one that scavenges, as a person who searches through refuse for food' or 'an animal, such as a bird or insect, that feeds on dead or decaying matter.' (The American Heritage Dictionary of the English Language 2009), Getz (2011) gives an incisive description of scavengers:

> *Scavenging is both a carnivorous and herbivorous feeding behavior in which the scavenger feeds on dead animal and plant material present in its habitat. The eating of carrion from the same species is referred to as cannibalism. Scavengers play an important role in the ecosystem by consuming the dead animal and plant material. Decomposers and detritivores complete this process, by consuming the remains left by scavengers*

Hamilton (2003) also describes the roots of the term "scavenger": *Scavenger* is an alteration of "scavager", from Middle English "skawager" meaning "customs collector", from skawage meaning 'customs', from Old North French "escauwage" meaning "inspection", from "escauwer" meaning "to inspect", of Germanic origin; akin to Old English "sceawian" meaning "to look at", and modern English "show".

Several points emerge from these definitions. First scavengers may be animals that are not exclusively scavengers, but may also derive sustenance using other methods. Second, true scavengers do indeed derive their food entirely or almost entirely from scavenging. Third, the food of the scavenger should be dead or decaying animal or plant matter. Fourth, scavengers may be birds, mammals, insects or even humans. Fifth, decomposers and detritivores, which consume the remains left by scavengers are not scavengers.

As mentioned above, scavengers may be further described as facultative scavengers (i.e., they are also predators, omnivores or herbivores that supplement their diet with decaying animal or plant or animal matter) or obligate scavengers that eat only carrion (Schmitz et al. 2008; Cortés-Avizanda et al. 2009a). The latter may be lesser in number, as carrion is not very common in natural contexts (Wilson and Wolkovich 2011). Cold climates may limit the availability of decaying matter, as decomposing bacteria are restricted. Hot temperatures in warmer climates may increase the action of decomposers, limiting carrion due to rapid decomposition (Selva et al. 2003; DeVault et al. 2004). Decomposers compete with scavengers by consuming carrion rapidly (Shivik 2006). Competition between scavengers, carnivores and decomposers may increase with limited edible matter (Schmitz et al. 2008).

Scavenger removal of animal carcasses is considered beneficial for the ecosystem (Sekercioglu 2006). In this setting, the avian scavenger, whether an eagle, vulture, stork or gull, possesses a unique role, due to its ability to cover large areas, and its visibility to associated ground dwellers, be they people, canines or felines, that may be able to interpret the avian scavenger's behavior and location for self-benefit. The avian and mammalian scavengers have a long history in the ecology of the Earth. They have close ties with the emergence of the age of large mammals and later extinctions, and the consequent proliferation of large carcasses. After this period, in prehistoric and historic times, scavengers and carnivores have had a strong relation with people, within an ecological setting in which people were important players and roles of carnivores overlapped with those of people.

Scavengers may also be described for their roles in the ecosystem. One role is that of energy transfer. Energy is transferred when scavengers eat carrion, sometimes accounting for as much as 50 per cent of the total energy transfer in the ecosystem (DeVault et al. 2003; Shivik 2006). Decaying meat has been described as a 'high quality nutritional source', as compared to decaying plant material it has a high protein content (i.e., high nitrogen:carbon ratio (Wilson and Wolkovich 2011). Scavengers also may reduce diseases that may result from the decomposition of dead animals, by consuming the meat before bacterial colonization during later putrefication (Von Dooren 2011).

The most important issue in scavenging is the food that is actually eaten. Such food is composed of dead plant or animal matter, and hence it is at a particular stage of decomposition. The science of decomposition is usually called taphonomy. Decomposition is the process of disintegration and tissue change that starts with the death of the organism and ends when it is either a skeleton or entirely destroyed. There are two main types of decomposition, abiotic (which occurs through chemical or physical processes) and biotic (also termed biodegradation, which involves the metabolic breakdown by organisms of matter into simpler components). Decomposition is crucial to the existence of the ecosystem, because it is the method by which living materials are returned to the inanimate earth, eventually to be recycled back into the living world through chemical uptake and food.

After death, when the heart of the animal stops beating and pumping blood, the body of the organism is in the fresh stage, when blood moves according to gravity. The muscles then harden (rigor mortis), the body cools (algor mortis), and during the chemical decomposition termed autolysis, cells lose their structure and enzymes are released. Oxygen within the body is depleted by the aerobic microbes in the body, creating a suitable environment for anaerobic organisms. These anaerobic organisms, from the respiratory system and gastrointestinal tract change carbohydrates, lipids, and proteins into organic acids (propionic acid, lactic acid) and gases (methane, hydrogen sulfide, ammonia). This leads to a situation termed bloating when the carcass is bloated with gases. Most tissues of multicellular organisms are putrescible, or subject to putrefaction upon death. The organic tissues that comprise living organisms, being stores of chemical energy, are broken down and simplified when death occurs, with the loss of the biochemical processes of life.

Putrefaction starts with the decomposition of the proteins in the tissue, with the result that the cohesion of the tissues is gradually destroyed, and some tissues are liquefied. The process of putrefaction may be accelerated in the case of animals by the action of microorganisms that were present within the digestive system during life, which after death, digest the proteins and excrete simpler products, including gases such as hydrogen sulphide, carbon dioxide, and methane, and amines including putrescine and cadaverine, the cause of the odor of decaying flesh. Intestinal anaerobic bacteria change haemoglobin to sulfhemoglobin, and the gases transport the sulfhemoglobin through the circulatory and lymphatic systems. The gases spread through the body cavities and then the blood vessels and tissues, bloating the body. When there is sufficient breakdown of the body tissues, the gases may escape, and the tissues further disintegrate, leading to the skeletonization of the body. The rate of putrefaction may vary greatly, the main determining factor being temperature, which either retards bacterial action (cold temperatures, as in refrigeration) or increases it (warm temperatures, as in tropical climates).

After the bloating and putrefaction stages, there is more active decay, the stage of greatest loss of mass to the body, which occurs when insects lay eggs in the flesh, and maggots (larvae) feed on the tissue. This results in the decomposition of the tissue under the skin, contributing to skin slippage and hair losses, and ruptures in the skin that allow more gases and fluids to escape, while oxygen enters through the ruptures, encouraging more development of aerobic microbes and insect larvae. After this active stage, there is the advanced decay stage, when insect larvae move from the body to pupate, and decomposition declines due to the loss of tissue. There may be loss of vegetation in the area around the body, and an increase in soil carbon, phosphorus, potassium, calcium, magnesium and nitrogen. After this stage, the former body is in a dry remains stage, merely bones, cartilage and possibly skin. It may be partially skeletonised if there is still some skin, or completely skeletonised if there is only bones remaining.

Carcasses may be recognized by the presence of insects, mammals or birds on the body, the stationary posture, the partial or total dismemberment of the body, or the loss of several body parts, which will be the norm when the death was due to carnivores. The amount of flesh remaining on a carcass depends on the stage of abandonment by the carnivores. As will be seen later, only vultures of the Genus Cathartes (the Turkey vulture, Greater Yellow-headed vulture and Yellow-headed vulture) are able to detect carrion by smell (although in most cases they probably use sight); all other vultures must rely on sight, using the indicators mentioned above. As will also be discussed later, different vulture species have different abilities at carcasses. The larger species are able to tear through the thick skin of large mammalian carcasses, while the smaller, weaker billed species either pull morsels from the carcass after it has been opened by carnivores or by the larger tearing species, or wait and pick small morsels from the bones. It is at this stage, the acquisition of food from carcasses, and how this varies among Species, Genera, Families and possibly Orders, and the enabling processes of foraging, reproduction and competition that the story of vultures begins.

1

Systematic List of Old World Vultures: The Griffons

1 INTRODUCTION

This chapter examines the forms, foraging and feeding habits, breeding patterns and statuses of the eight species of Griffon vultures of the Genus Gyps (Savigny 1809). The Gyps vultures are a genus of Old World vultures in the family Accipitridae, which also includes eagles, kites, buzzards and hawks. Compared to other vultures, the heads of Gyps species are more feathered, with a characteristic downy cover. The eight Gyps species are: the White-backed vulture (*Gyps africanus*); White-rumped vulture (*Gyps bengalensis*); Cape Griffon (*Gyps coprotheres*); Griffon vulture (*Gyps fulvus*); Himalayan vulture (*Gyps himalayensis*); Indian vulture (*Gyps indicus*)—formerly Long-billed vulture; Rüppell's vulture (*Gyps rueppellii*); and Slender-billed vulture (*Gyps tenuirostris*)—formerly included in *G. indicus*. A prehistoric species, *Gyps melitensis* is known only from fossil remains found in Middle to Late Pleistocene sites all over the central and eastern Mediterranean.

Gyps species are unique among Old World vultures in that they feed exclusively as scavengers, whereas other vultures are also known to kill their prey on occasions or, rarely, to feed on fruits (i.e., the Palm-nut vulture *Gypohierax angolensis* (Houston 1983; Mundy et al. 1992; del Hoyo et al. 1994; Johnson et al. 2006). Specialization in feeding behavior among Gyps vultures is thought to have evolved due to their close association with ungulate populations, particularly migratory herds in Africa and Asia. In fact, the observed temporal and geographic diversification of Gyps vultures coincides with the diversification of Old World ungulates, especially those of the family Bovidae (Vrba 1985; Arctander et al. 1999; Hassanin and Douzery 1999; Matthee and Davis 2001), and the expansion of grass-dominated ecosystems in Africa and Asia (Jacobs et al. 1999). These close associations likely played a significant role in the adaptation and rapid diversification of Gyps vultures. Indeed, Houston (1983) proposed that their large body size and ability to soar over large distances in search for food are related to the associated migrant distributions and seasonal fluctuations in the mortality of ungulates, and that they have consequently become incapable of actually killing their own prey (Ruxton and Houston 2004).

The Indian vulture, Rüppell's Griffon vulture and the Common Griffon vulture have been argued to be polytypic or descended from several sources (Mayr and Cottrell 1979; Sibley and Monroe 1990; del Hoyo et al. 1994; Ferguson-Lees and Christie 2001). Wink and Sauer-Gürth (2000) found that *G. rueppellii* and *G. himalayensis* may be closely related in a monophyletic group with *G. coprotheres* and *G. fulvus*, based on nucleotide squences of the cytochrome b gene. Arshad et al. (2009a) supported this position and argued that there was a recent, rapid diversification among the Gyps vultures, possibly related with the diversification of wild ungulates in the Old World. *G. bengalensis* and *G. africanus* were formerly classified together as a separate species, *Pseudogyps*, as unlike other Gyps species they shared a smaller body size and a reduced number of rectrices (wing feathers, 12 vs. 14 for the other species) (Mundy et al. 1992; Sharpe 1873, 1874; Peters 1931). In addition, proposals were made to consider the 'long-billed' vultures as two separate species (*G. indicus* and *G. tenuirostris*) based on morphological differences (Grey 1844; Hulme 1869, 1873; Rasmussen et al. 2001, 2005), and the taxonomic status of the two subspecies of the Eurasian vulture (*G. f. fulvus* and *G. f. fulvescens*), as well as their characteristics and geographic distribution are unclear. Currently, taxonomic relationships among Gyps species, including subspecies relationships, have yet to be fully studied with molecular sequence characters, and the validity of fulvescens has not been considered in recent times (Hulme 1869, 1873; Jerdon 1871).

1.1 White-rumped Vulture (*Gyps bengalensis* Gmelin 1788)

Physical appearance

The White-rumped vulture (*Gyps bengalensis*), a typical griffon, is the smallest of the griffons, but is still a very large bird. As a medium-sized vulture it weighs between 3.5 and 7.5 kg (7.7–16.5 lbs), is between 75 and 93 cm (30–37 in) in length, and has a wingspan of 1.80–2.6 m (6.3–8.5 ft) (Alstrom 1997; Ferguson-Lees et al. 2001; Rasmussen and Anderton 2005).

The dominant plumage is blackish, with slate-grey to silvery secondaries (Fig. 1.1a; see also Fig. 1 for an illustration of the locations of the various feathers). The underside is marked with whitish streaks and the back, rump

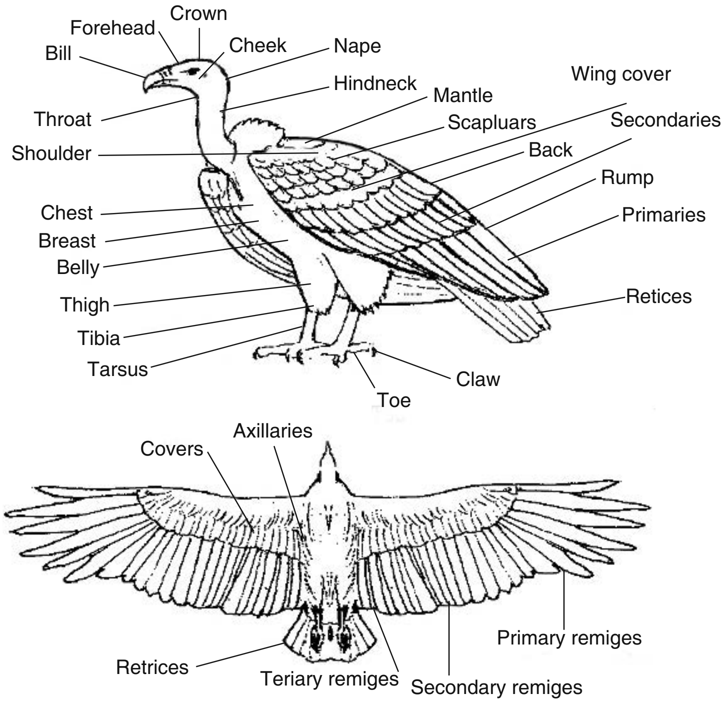

Fig. 1. Feathers on a Vulture.

and underwing coverts are whitish. The neck is unfeathered, partly down covered, slightly pink or maroon tinted, with a white neck ruff slightly open at the front, the bill is large with slit nostrils. The wings have dark edges and white linings, and black undertail coverts are visible on an adult bird in flight (Rasmussen and Anderton 2005). The coloration of this species therefore differs strongly from the White-backed vulture of Africa.

The juveniles acquire adult plumage at the age of four to five years (Fig. 1.1b). The juvenile is described as dark brown, with thin whitish streaks. Some feathers, especially the mantle and scapulars, lesser and median coverts are dark brown, while the greater coverts are blackish brown. The lower back and rump area are brown rather than white as in the adult (Rasmussen and Anderton 2005). The bare skin of the head is colored greyish-white, and the neck may also be tinged pinkish or bluish, with a dark grey throat. Both the head and neck are covered with scattered pale brown, grey and/or offwhite feathers. The cere and the bill are blackish, and the top of the upper mandible is pale bluish in the subadult. The legs,

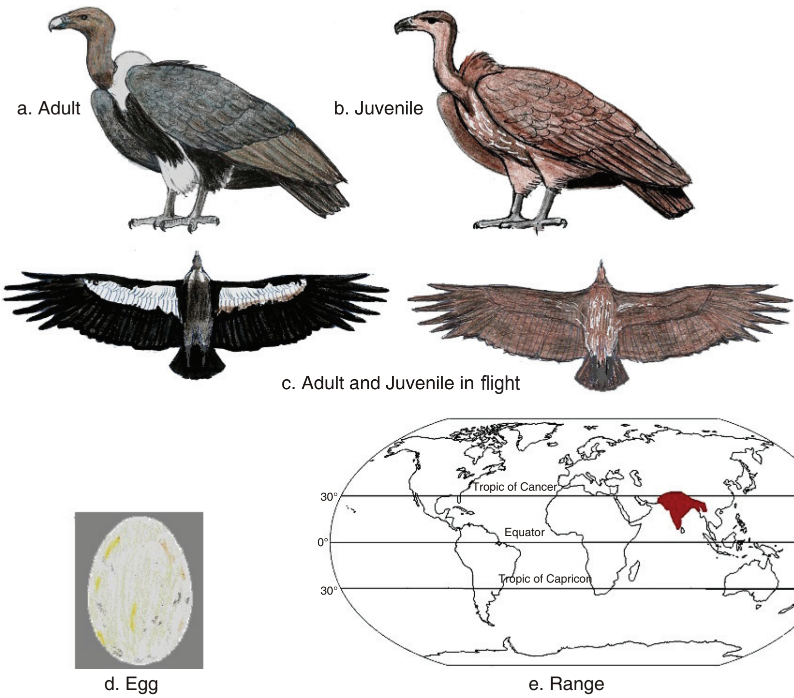

Fig. 1.1. White-rumped Vulture.

feet and iris of the juvenile are the same as those of the adult. The subadult is intermediate between the juvenile and the adult (Alstrom 1997).

In flight from below, white wing-linings on the wings, and black undertail coverts, are visible on an adult bird (Rasmussen and Anderton 2005). There are white underwing-coverts, with dark leading edges, contrasting with the blackish body (Fig. 1.1c).

Classification

The White-rumped vulture was once classified as closely related to the African White-backed vulture. *G. bengalensis* and *G. africanus* have been classified by some as a separate genus, Pseudogyps. As mentioned above, this was based on physical attributes; the smaller body size compared to other species, and the smaller number of rectrices or tail feathers (12 vs. 14) compared to other Gyps vultures (Mundy et al. 1992; Sharpe 1873, 1874; Peters 1931). Although not all scientists agree with this classification, Lerner et al. (2006: 169) found a very close genetic match between the two white-backed vultures. For example, Seibold and Helbig (1995) argue that molecular data do not support the split from Gyps to a separate genus. As can be seen in the diagrams, its coloration differs strongly from the white-backed vulture of Africa (Fig. 1.1d). Wink (1995: 877) noted 'we suggest that the name Pseudogyps should be omitted and the respective taxa included in the Genus Gyps. *G. africanus* clearly differs from *G. bengalensis*, indicating that both vultures represent distinct species' (see also Dowsett and Dowsett-Lemaire 1980).

Foraging

The White-rumped vulture, in common with other vultures, begins foraging in the morning, when the thermals are strong enough to allow extensive soaring flight. Due to their comparatively smaller size, they are dominated by the larger Asian vultures, such as the Red-headed vulture. The main foraging and nesting areas are open plains and sometimes hilly areas, with grass, shrubs and light forest. A highly social vulture, it nests and roosts in large numbers, usually on trees near human habitation (Cunningham 1903; Morris 1934; Ali et al. 1978).

Breeding

For the nesting and egg-laying period, a study by Baral and Gautam (2007) found that the egg-laying period occurred from late September to late October, the incubation period from December to January and the nesting period from February to May. This was supported by a study by Sharma (1969: 205) in Jodhpur, India which noted that 'fuller nesting behavior gets under way only during December, when minimum temperatures drop to about 11ºC and relative humidity to about 50%.' These nesting activities peak in January when the minimum temperatures are reached (about 8ºC), the relative humidity is around 50% and the days are the shortest (10.24 hours). In February into March, the temperatures rise to 14ºC and above, and the relative humidity is around 60%. The researchers conclude that 'low temperatures, short days and high relative humidity favor breeding in *G. bengalensis*, while rising temperatures and falling humidities are adverse.' Eggs are elliptical, white, sometimes with a few reddish brown marks, with a chalky surface (Fig. 1.1e). General dimensions are 87.9 x 69.7 and 84.4 x 66.4 mm (Wells 1999).

Different nesting locations have been recorded (Baral and Gautam 2007; Sharma 1970). Baral and Gautam state that trees are favored in the Rampur Valley, Nepal. This study located 42 nesting trees, comprising 33 *kapok* trees, 2 *khair* and 1 each of the other seven tree species (*barro*, *kavro*, *ditabark*, *tuni*, *padke*, *saj* and *karma*). The *kapok* (*Ceiba pentandra* Linnaeus) Gaertn. is a very large tree that grows 60–70 m (200–230 ft) tall with a butressed trunk of up to 3 m (10 ft) in diameter (Gibbs and Semir 2003). The *barro* (*Terminalia chebula* Retz.) is also a large deciduous tree growing up to 30 m (98 ft) tall, and a trunk up to 1 m (3 ft 3 in) thick (Saleem et al. 2002). Similar species are the *kavro* (*Ficus religiosa* L.) (Singh et al. 2011), ditabark *Alstonia scholaris* L.R. Br. (World Conservation Monitoring Centre 1998), the *saj* (*Terminalia alata* Heyne ex Roth, or *Terminalia tomentosa* (Roxb.) Wight & Arn.) and the *karma* (*Adina cordifolia*) (Willd. ex Roxb.) Benth. and Hook.f. ex Brandis. The *khair* (*Senegalia catechu* (L.f.) P.J.H. Hurter & Mabb) is slightly smaller, growing to about 15 m in height. The Padke, also known as the Persian Silk tree or the Pink Silk tree (Albizia julibrissin Durazz., 1772 non sensu Baker), 1876 is a smaller deciduous tree growing to only 5–12 m (Gilman and Watson 1993). Sharma's study (1970: 205) states that vultures use both cliffs and trees, cliffs being favored because they require fewer twigs and are a safer refuge from predators. For trees, favored species include the very large banyan tree (*Ficus begalensis* L.) and in more arid areas the large *Prosopis spicigera* L., this latter species described as the only 'tree that meets the vultures' nesting requirements.'

Population status

The distribution of the White-rumped vulture is shown in Fig. 1.1e. Recently, the White-rumped vulture was considered one of the commonest raptors worldwide, but its numbers have greatly declined (Gilbert et al. 2003, 2006; Green et al. 2004; Baral et al. 2005; Gautam et al. 2005; Arshad et al. 2009b; BirdLife International 2001, 2012; Cuthbert et al. 2011a,b; Chaudhary et al. 2012). This species was common in Myanmar in the nineteenth century, especially near the Gurkha cattle-breeding villages. Extensive populations were also recorded by Macdonald (1906), Hopwood (1912) and Stanford and Ticehurst (1935, 1938–1939).

1.2 White-backed Vulture, *Gyps africanus* (Salvadori 1865)

Physical appearance

The White-backed vulture is a medium-sized vulture, slightly larger than the White-rumped vulture. The body mass is 4.2 to 7.2 kg (9.3–16 lbs), it is 78 to 98 cm (31 to 39 in) long and has a 1.96 to 2.25 m (6 to 7 ft) wingspan (Ferguson-Lees et al. 2001). The dark tail and flight feathers, contrast with the lighter brown to cream-colored body feathers. The rump is white. The head is paler than the neck. The only other similar birds within its range are *G. fulvus*, and *G. rueppellii*, but these species are larger and have less contrast between the flight feathers and underwing-coverts (Fig. 1.2a,b,c).

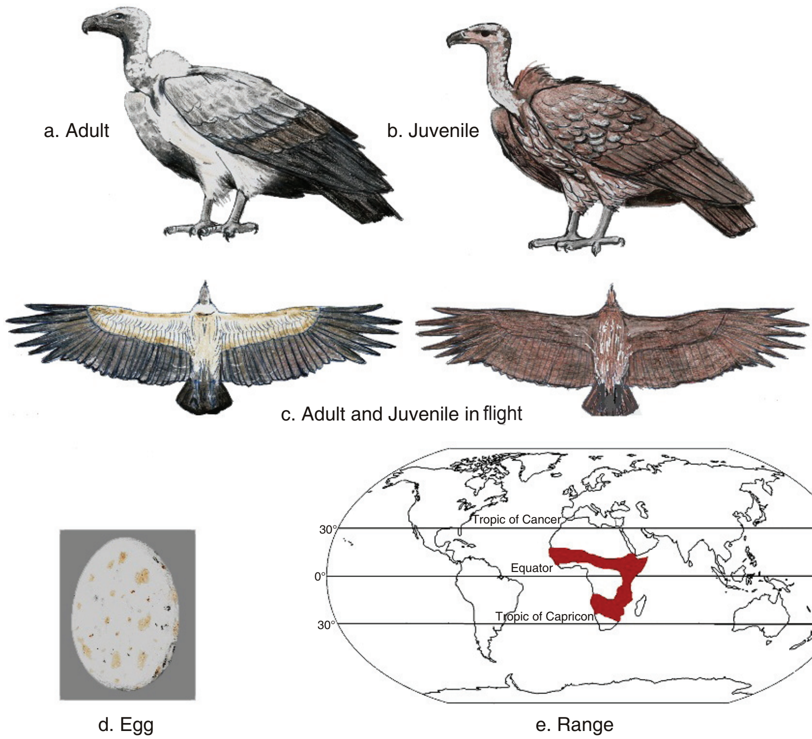

Fig. 1.2. White-backed Vulture.

Classification

The White-backed vulture, as described above, is closely related to the Indian White-rumped vulture, to the extent that they were (and still are in some publications) classified together, but 'grouping of bengalensis and africanus together in the Genus Pseudogyps, as historically proposed, is not upheld based on mitochondrial data' (Johnson et al. 2006: 65).

Foraging

The White-backed vulture frequents open wooded savanna, particularly areas of acacia. Phipps (2011) notes that the foraging preferences of this species are poorly understood, but its occurrence is linked to free ranging ungulates in open land. The Serengeti ecosystem in Tanzania has been cited as a good foraging ecosystem for this and other species of African vultures, based on the habitat of large wild ungulates and the carnivores that kill them to provide food for vultures (Houston 1974).

Breeding

For the nesting and egg-laying period, a study by Virani et al. (2010) in the Serengeti National Park of Tanzania found the peak period to be mid-April. Vultures may deliberately select this period for fledgling as it coincides with the peak of ungulate carcass availability (Houston 1976). Another study by Herholdt and Anderson (2006) in Kgalagadi Transfrontier Park, Botswana, found that most White-backed vultures laid eggs in June. Nesting periods were observed to start in May to June in Zimbabwe, and June to July in Swaziland and KwaZulu-Natal (Monadjem 2001). Only one egg is laid (Fig. 1.2d) and incubated for about 56 days. The chick is fledged after about four months. However, Virani et al. (2012) note that despite the single annual breeding season in southern Africa (as also noted by Mundy et al. 1992), in East Africa there is a bimodal breeding season, with nesting in April/May and December/January (as also reported by Ferguson-Lees and Christie 2001), and peak egg laying between March and May (Houston 1976).

Colonial nesting usually involves ten or fewer pairs, with one or occasionally two nests per tree (Mundy et al. 1992; Monadjem and Garcelon 2005). Nesting is usually in large, crowned trees in loose colonies, near rivers (Mundy et al. 1992; Bamford et al. 2009a, 2009b). Malan (2009) observed, nesting White-backed vultures predictably selected the tallest trees available. Studies by Varani et al. (2010) in the Masai Mara in Kenya, and by Monadjem and Garcelon (2005) and Bamford et al. (2009a) in Swaziland found that the White-backed vulture nests mostly in tall trees in riparian vegetation. Other studies found that nesting trees were a minimum of 11 m tall (Houston 1976; Monadjem 2003a; Herholdt and Anderson 2006). A study by Comba and Simuko (2013) found that the average height of nests in Zambia was 16.6 m. Other heights for nests were 19 m in Zimbabwe (Mundy 1982), 14 m in the Kruger National Park (Tarboton and Allan 1984), 13 m in Swaziland (Monadjem 2003) and 7 m in Kimberly (Mundy 1982). Common tree species for nests are *Faidherbia albida* [(Delile) A. Chev.], which grows from 6 to 30 m tall; *Vachellia xanthophloea* [(Benth.) P.J.H. Hurter], which grows up to 15–25 m and *Senegalia nigrescens* [(Oliv.) P.J.H. Hurter] which grows up to 18 m in height. Occasionally, these vultures nest on pylons in South Africa (Anderson and Hohne 2007; Malan 2009).

Population status

The distribution of the White-backed vulture is shown in Fig. 1.2e. This species has been described as the most widespread and common vulture in Africa, but in recent times it has declined (Thiollay 2006; McKean and Botha 2007; Ogada and Keesing 2010; Otieno et al. 2010). The population reduction in Western Africa is over 90% in some areas (Thiollay 2006). There have been population reductions in the Sudan (Nikolaus 2006), Kenya (Virani et al. 2011) and southern Africa (Hockey et al. 2005) Declines in Tanzania and Ethiopia are disputed (Nikolaus 2006). The conservation status has been upgraded from Least Concern to Near Threatened (BirdLife International 2007).

Habitat conversion to agro-pastoral systems, loss of wild ungulates leading to a reduced availability of carrion, hunting for trade, persecution and poisoning are factors for the declining population (Virani et al. 2011). The diclofenac compound, used to reduce pain and inflammation in livestock, acts as a poison as African and Asian vultures are vulnerable to its effects (Swan et al. 2006; Naidoo and Swan 2009; Ogada and Keesing 2010; Otieno et al. 2010; Phipps 2011). In Kenya, the toxic Carbamate-based pesticide Furadan™ has killed many vultures (Maina 2007; Mijele 2009; Otieno et al. 2010). In southern Africa, some birds are killed and eaten for perceived medicinal and psychological benefits (McKean and Botha 2007). Electrocution from powerlines is common in some areas (Bamford et al. 2009). In addition, the ungulate wildlife populations on which this species relies have declined precipitously throughout East Africa, even in protected areas (Western et al. 2009).

1.3 Slender-billed Vulture (*Gyps tenuirostris*)

Physical appearance

The Slender-billed vulture is another medium-sized vulture. Compared to the other Gyps species, this species appears smaller-headed, larger-eyed, longer-billed, longer-legged, ragged, dingy, and graceless with a less feathered head and neck, and 'large prominent ear canals that are noticeable even at a distance, not like the smaller ones in the Indian vulture and other Gyps vultures' (Rasmussen et al. 2001: 25).

Seen from a perch, adults have a black, nearly featherless head and neck, a dark bill with a pale culmen and a black cere, and a dirty white ruff. Brown is the dominant feather color with lighter colored streaked underparts, and white thigh patches. Juveniles differ in having white down on the upper neck and nape, and streaked upperparts (BirdLife International 2014). Subadults are intermediate between adults and juveniles (Rasmussen et al. 2001) (Fig. 1.3a,b,c).

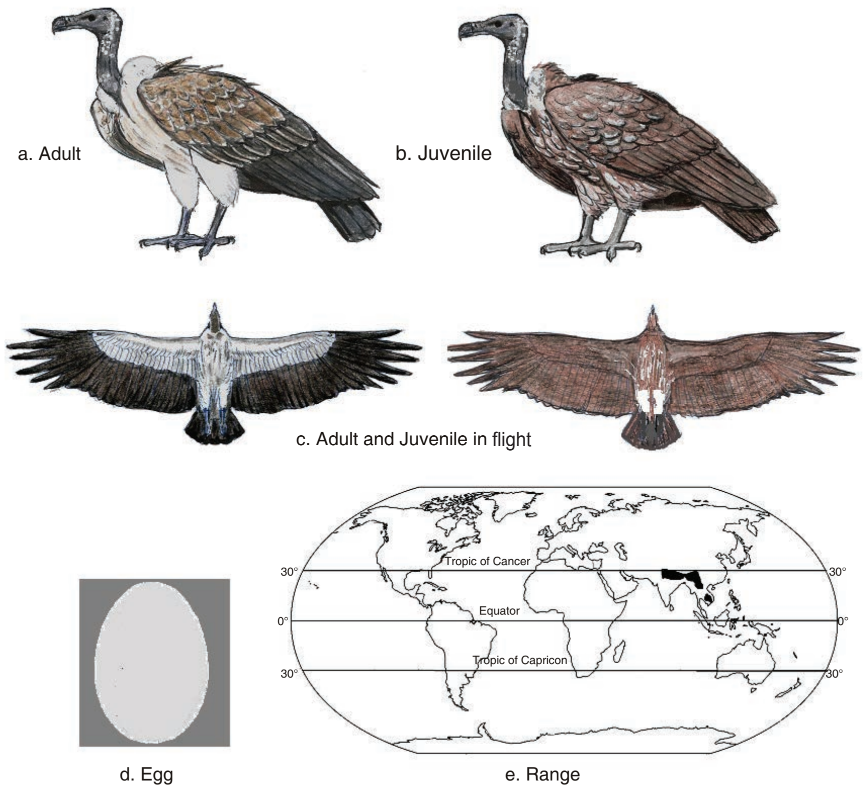

Fig. 1.3. Slender-billed Vulture.

Classification

The Slender-billed vulture was formerly classified with the Indian vulture *Gyps indicus* as the Long Billed vulture *Gyps indicus tenuirostris*, but is now recognized as a different species (Rasmussen and Parry 2000). Arshad et al. (2009a) studied the phylogeny and phylogeography of the Gyps species, using nuclear (RAG-1) and mitochondrial (cytochrome b) genes, and concluded that *G. indicus* and *G. tenuirostris* are separate species. The Slender-billed vulture differs from the Indian vulture in having a slenderer bill and darker brown plumage (Hall et al. 2011). The two species are also found in different regions. The Slender-billed vulture, a tree nester, is found in Southeast Asia north to the Sub-Himalayan regions. The Indian vulture, mostly a cliff nester, is found south of the Ganges in India.

Foraging

The Slender-billed vulture shares similar habitat with the White-rumped vulture, i.e., open grassland, savanna or mixed dry forest with open patches, near or far from human habitation (Baker 1932–1935; Lekagul and Round 1991; Robson 2000; Satheesan 2000a,b; BirdLife International 2001). This is reflected in its diet, which comprises carcasses of domestic animals, and wild deer and pigs killed by tigers (Sarker and Sarker 1985). In Nepal, their main diet comprises domestic livestock rather than wild ungulates (Baral 2010).

Breeding

The breeding season is December–January, recorded in studies in India (Baker 1932–1935), Myanmar (Smythies 1986) and in Kamrup district, Assam (Saikia and Bhattacharjee 1990c). Only one egg is laid in regularly used nests (Brown and Amadon 1968), sometimes in groups of up to 16 birds (Baker 1932–1935) (Fig. 1.3d).

The Slender-billed vulture usually nests in large trees, such as the larger woody trees of the Genus Ficus, e.g., *Ficus religiosa*. This is a large deciduous or semi-evergreen tree up to 30 m (98 ft) tall, with a trunk diameter of up to 3 m (9.8 ft). Nests are located near or far from human settlement, usually 7 to 14 m (23–46 ft) high (Baker 1932–1935; Ali and Ripley 1968–1998; Brown and Amadon 1968; Grubh 1978; del Hoyo et al. 1994; Alström 1997; Grimmett et al. 1998; Rasmussen and Parry 2000). Nesting trees are the mango (*Mangifera indica* L.) and *kadam* (*Anthocephalus indicus* A. Rich.) in Kamrup district, Assam (Saikia and Bhattacharjee 1990). Other large trees were used for nesting in Myanmar (Smythies 1986) and in Khardah, Calcutta (Munn 1899, cited in BirdLife International 2001).

Population status

The distribution of the Slender-billed vulture is shown in Fig. 1.3e. It was one of the most numerous vultures in Southeast Asia during the first half of the twentieth century (Ferguson-Lees and Christie 2001; Pain et al. 2003; Hla et al. 2010; Prakash et al. 2012). The population of this species, in combination with the Indian vulture, declined to 3.2% of its former level in 2007 in India (Prakash et al. 2007) with similar declines in Nepal (Chaudhary et al. 2012). Diclofenac, the anti-inflammatory drug for the treatment of livestock, contributed to renal failure, visceral gout and death in vultures (Oaks et al. 2004a; Shultz et al. 2004; Swan et al. 2005; Gilbert et al. 2006). The veterinary drug ketoprofen, was also toxic in concentrations (Naidoo et al. 2009). Processing of dead livestock also reduced vulture access to carcasses (Poharkar et al. 2009).

1.4 The Indian Vulture (*Gyps indicus*) (Scopoli 1786)

Physical appearance

The Indian vulture is closely related to the Slender-billed vulture; in fact as noted above, both species were once considered one species, the Long-billed vulture. It is also smaller and more lightly-built than the Eurasian Griffon *Gyps fulvus*, with a weight of 5.5 to 6.3 kg (12–13.9 lbs), a body and tail length of 80–103 cm (31–41 in) and a wingspan of 1.96 to 2.38 m (6.4 to 7.8 ft) (Ferguson-Lees and Christie 2001).

This species has a pale yellowish bill and cere, a large fluffy white ruff, buff back and upperwings (with larger feathers containing dark centers that give the back 'a broadly scalloped appearance'); the neck is blackish with pale down on the upper hind neck, and pale yellow feet; in flight its thighs are similar in color to the underparts (Rassmussen et al. 2001: 24). Juveniles have a darker bill and cere, a pinkish head and neck covered with light colored down and heavily streaked plumage (Fig. 1.4a,b,c). Subadults are intermediate between the adults and juveniles (Rassmussen et al. 2001).

Classification

The physical differences between this species and the Slender-billed vulture, and the fact that their ranges do not overlap, contributed to the reclassification of the Long-billed vulture into the two species (Rasmussen and Parry 2001). Compared with the Slender-billed vulture, it has a shorter, deeper bill, a thicker partly down-covered neck (the other species has no down), a fluffier ruff, a clean buff rather than 'dingy' buff coloration of the back and upper wing coverts, lower feathers and uppertail coverts lacking dark centers, pale tipped upper- and uppertail-coverts and less downy outer leg feathers (Rassmussen et al. 2001: 25).

Foraging

This species is found in cities, towns and villages near cultivated areas, and in open and wooded areas. It also forages in open and wooded areas, and often in association with the White-rumped vulture when scavenging (BirdLife International 2012).

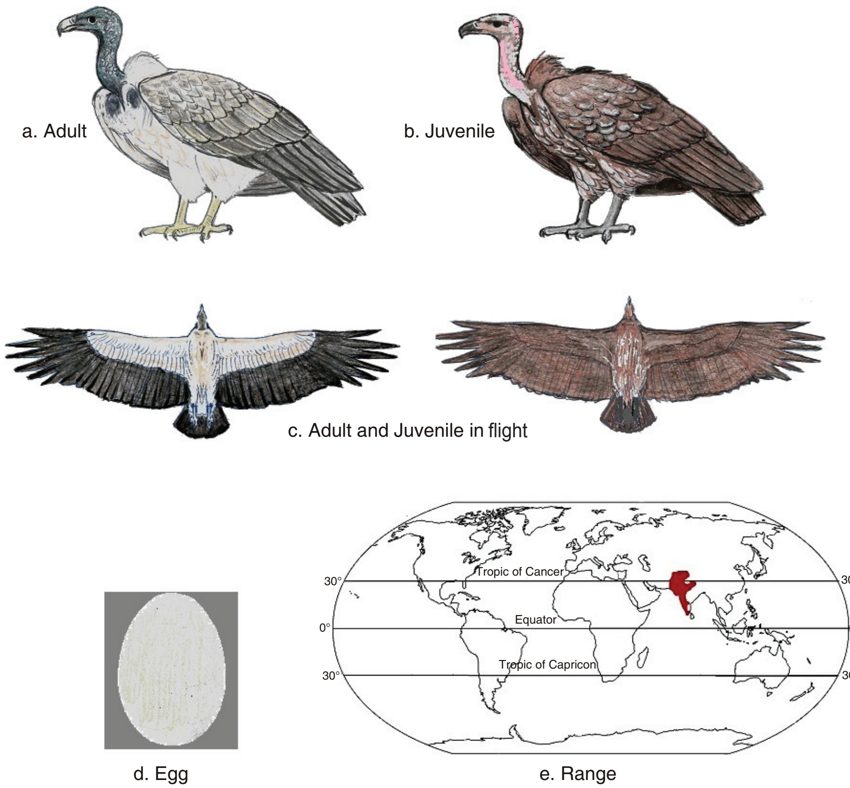

Fig. 1.4. Indian Vulture.

Breeding

The Indian vulture is mostly a colonial cliff nester (Ali and Ripley 1968–1998; Brown and Amadon 1968; del Hoyo et al. 1994; Alström 1997; Grimmett et al. 1998). A survey of the vultures present in Sindh, Pakistan by Iqbal et al. (2011) found all the vultures' nests on cliffs. In India, nests are usually built by small colonies of 2 to 12 pairs on cliff-face ledges and/or rock outcrops (Baker 1932–1935). Exceptions on record included a large colony of 50 nests at Taragurh hill, Rajasthan reported by Baker (1932–1935) and one of 30 pairs mentioned recorded by Hume and Oates (1889–1890). In Pakistan, colonies of 3–16 nests existed on outcrops up to the altitude of 325 m (Roberts 1991–1992). Subramanya and Naveein (2006) describe a nest 35 m up a steep-sided cliff, on the south side of the Ramadevarabetta hills, south-west of Bangalore (Karnataka, India).

However, in some areas, such as Rajasthan, tree nesting has been recorded (Naoroji 2006). Chhangani (2009: 65) notes that the Indian vultures in the Great Indian Thar desert of Rajasthan nested in both cliffs and trees, 'an aspect requiring more intensive work.' Mukherjee (1995), reported trees for nesting sites, but Collar, Andreev, Chan, Crosby, Subramanya and Tobias (the editors of Threatened Birds of Asia; The Bird Life International Red Data, Book, Bird Life International 2001: 618) argue that as there are no other reports of tree-nesting, this assertion 'may therefore be doubtful; it certainly requires verification.'

The breeding season in India is November–March, mostly concentrated between December and January for both India (Baker 1932–1935) and Pakistan (Roberts 1991–1992). Only one oval white egg is laid (Barnes 1885; Hume and Oates 1889–1890; Brown and Amadon 1968; Roberts 1991–1992). The incubation period for the egg is estimated to be about 50 days (Brown and Amadon 1968) (Fig. 1.4d).

Population status

The distribution of the Indian vulture is shown in Fig. 1.4e. As noted by Chaudhry et al. (2012) and Thiollay (2000) Long-billed vultures (including the current Indian vulture) and White-rumped vultures were the most abundant vultures in South Asia during the first half of the twentieth century. Now, they have severely declined in numbers.

1.5 Rüppell's Vulture (*Gyps rueppelli*) (Alfred Brehm 1852)

Physical appearance

The Rüppell's Griffon vulture, or the Rüppell's vulture, named after Eduard Rüppell, a nineteenth century German explorer, collector, and zoologist, is found mainly in the Sahel Savanna region of western and central Africa, between the Sudanian Savannas to the south and the Sahara Desert to the north (see Part 2, Chapter 6, 6.2. for a discussion of these terms). It is a large vulture, having a body length of 85 to 103 cm (33 to 41 in), a wingspan of 2.26 to 2.6 metres (7.4 to 8.5 ft), and a weight of 6.4 to 9 kg (14 to 20 lb) (Ferguson-Lees and Christie 2001). It is similar to the White-backed vulture, *Gyps bengalensis*, but has a yellowish bill and is considerably larger. The head and neck are covered with white down feathers, and the base of the neck has a white collar. The plumage is mottled brown to dark brown or black with a mixed white-brown underbelly (Fig. 1.5a,b,c).

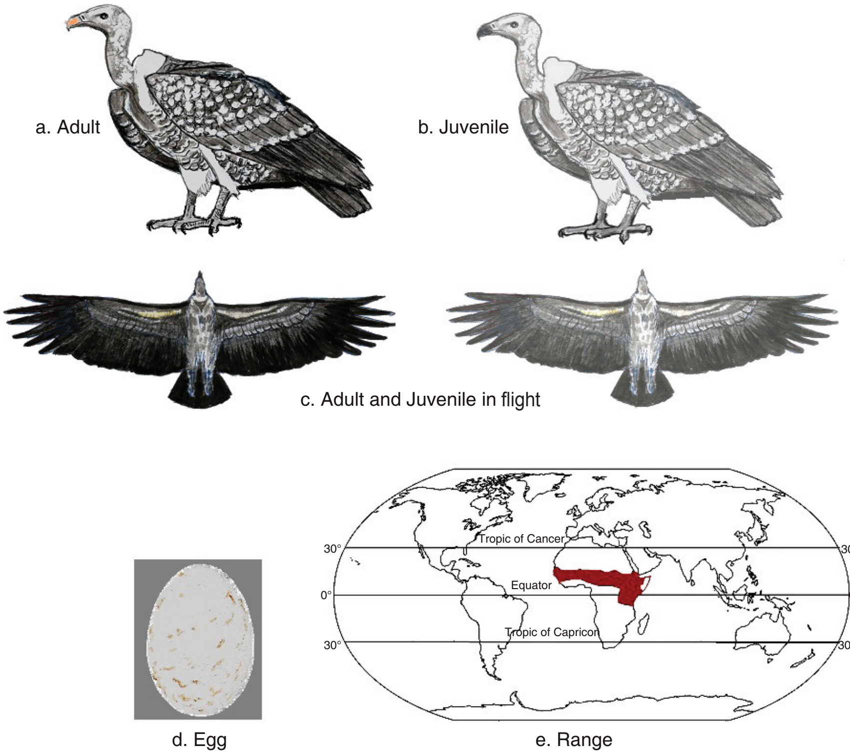

Fig. 1.5. Rüppell's Griffon vulture.

Classification

The Rüppell's Griffon vulture is closely related to the other species of the Genus Gyps. A study by Johnson et al. (2006: 65) using phylogenetic results from mitochondrial cytB, ND2 and control region sequence analysis 'supported a sister relationship between the Eurasian Vulture (*G. f. fulvus*), and Rüppell's Vulture (*G. rueppellii*), with this clade being sister to another consisting of the two taxa of "Long-billed" vulture (*G. indicus indicus* and *G. i. tenuirostris*), and the Cape Vulture (*G. coprotheres*)'.

Foraging

The foraging of this species is dependent on the large ungulate herds on the savannas. Migratory ungulates within the vultures' range, especially in East Africa include Blue Wildebeest (*Connochaetes taurinus*, Burchell

1823) Burchell's Zebra (*Equus burchelli* Gray 1824) and Thomson's Gazelle (*Eudorcas thomsonii*, Günther 1884) (Boone et al. 2006). A study by Kendall et al. (2012) found that the average number of Rüppell's vulture was higher during the ungulate migration season, enabling a fast response to wildlife density changes (Mundy et al. 1992; Kendall et al. 2012).

The Rüppell's Griffon is the commonest vulture of the Sahel savanna of Chad and Niger in West-Central Africa, Wacher et al. (2013). Here it feeds mostly on the carcasses of livestock (mostly camels, cattle, goats, horses and donkeys) rather than the outnumbered wild ungulates such as Dorcas Gazelle (*Gazella dorcas*, L. 1758), and to a lesser extent Dama Gazelle (*Nanger dama*, Pallas 1766) Barbary Sheep (*Ammotragus lervia*, Pall., 1777) and Addax (*Addax nasomaculatus*, de Blainville 1816). Rüppell's griffons in the Serengeti have been recorded as flying up to 150 km from the nest site to food source among the herds of migratory ungulates (Houston 1974b). Pennycuick (1972) suggested that the average foraging radius may be as far as 110 km.

The Rüppell's Griffon vulture is the world's highest-flying bird. An individual was involved in collision with an airplane over Abidjan, Côte d'Ivoire, at 11,000 metres or 36,100 ft. This species has a specialized variant of the hemoglobin alpha^{D} sub-unit which has a high affinity for oxygen which allows the species to absorb oxygen efficiently despite the low partial pressure in the upper troposphere (Laybourne 1974; Hiebl et al. 1988; Weber et al. 1988; Storz and Moriyama 2008).

Breeding

The breeding season of the Rüppell's Griffon varies greatly. For example, Virani et al. (2012) describe a colony in Kwenia, southern Kenya, composed of 150 to 200 adults (from 2002 and 2009) with a maximum of 64 nests occupied at any time. Egg laying dates varied each year; in some cases there were two egg-laying periods in one year (Fig. 1.5d). The number of nests was correlated with the previous year's rainfall. Ungulate populations in this area may have influenced breeding. The study concludes that nesting in Rüppell's vultures 'may be triggered' by rainfall and geared to producing fledged young at the end of the dry season (July–October) when carrion is most 'abundant' (ibid. 267). This point is also noted by Houston (1976). In another study, Houston (1990) found that the breeding time for colonies in the Serengeti region of Tanzania changed by 5 months between 1969–1970 and 1985, possibly correlated to the changes in ungulate populations. Food availability may have influenced two alternate breeding seasons, the choice of each period depending on the food available (Bouillault 1970; Mendelssohn and Marder 1989; Schlee 1988).

Nests may be in cliffs or rock outcrops or in trees. Tree nesting, considered atypical, has been recorded in West Africa (Rondeau et al. 2006). Wacher et al. (2013) give a detailed survey of Rüppell Griffon nesting and foraging presence in Chad and Niger in West-Central Africa (see also Scholte 1998). Of the 572 Rüppell's vultures recorded in the survey 47 nested on rocky inselbergs and 24 in tree crowns. Also, there were 24 cases of Rüppell's vultures using treetop stick nests, mostly on the crowns of the flat-topped thorny trees. Common tree species for nesting were the desert date (*Balanites aegyptiaca* (L.) Delile 1812) a medium-sized tree and to a lesser extent jiga (*Maerua crassifolia* Forssk), a slightly smaller tree (Wacher et al. 2013).

Population status

The distribution of the Rüppell's Griffon vulture is shown in Fig. 1.5e. Rüppell's Griffon vulture is considered near threatened by conservationists. In West Africa there have been severe declines in Mali, South Sudan, Burkina Faso, Mali, Niger, Cameroon, Uganda, Kenya, Somalia and Malawi and may be extinct in Nigeria (Rondeau and Thiollay 2004; Thiollay 2001, 2006; Nikolaus 2006; Virani 2006; BirdLife International 2014). One contributory factor may be the conversion of natural landcover to agriculture and urban landscapes (Buij et al. 2012). Other factors for the decline of the population of this species are poisoning from the toxic pesticide carbofuran, mostly in East Africa (Ogada and Keesing 2010; Otieno et al. 2010; Kendall and Virani 2012), the reduction of the ungulate wildlife populations (Western et al. 2009), diclofenac (BirdLife International 2007) and a substantial trade in vulture flesh and body parts, mostly in West Africa (Rondeau and Thiollay 2004; Nikolaus 2006). Possibly, there are also impacts from the actions of human climbing expeditions near the rocky outcrops in the Hombori and Dyounde massifs of Mali during the breeding season (Rondeau and Thiollay 2004).

1.6 Cape Vulture (*Gyps coprotheres*) (Forster 1798)

Physical appearance

The Cape Griffon vulture or Cape vulture is a large to very large vulture, larger than the Rüppell's or White-backed vultures. It occurs only in southern Africa, i.e., South Africa, Lesotho, Botswana, and is labelled as 'Critically Endangered' in Namibia (Simmons and Brown 2007). The length from bill to tail end is about 96–115 cm (38–45 in), the wingspan about 2.26–2.6 m (7.4–8.5 ft) and the weight 7–11 kg (15–24 lb) (Ferguson-Lees and Christie 2001). The coloration for an adult is creamy-buff, which contrasts with dark flight and tail feathers. The neck ruff is pale buff to dirty white.

Light silvery feathers and a black alula are visible in the underwing during flight. A black bill and its slightly larger size distinguish this species from the Rüppell's Griffon vulture. The juveniles have a darker, streaked plumage and a reddish neck (Fig. 1.6a,b,c).

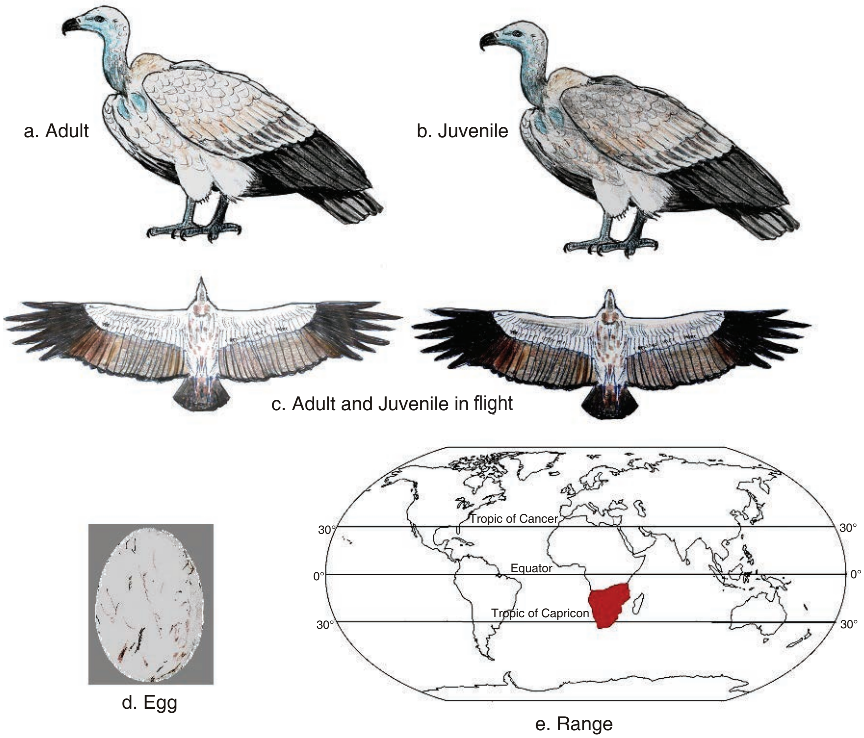

Fig. 1.6. Cape Vulture.

Classification

Johnson et al. (2006: 72) in a molecular study of the Gyps genus, noted a strong relation between *G. coprotheres*, *G. i. indicus* and *G. i. tenuirostris* in a clade, with these related to another clade of *G. f. fulvus* and *G. rueppellii*. Older publications held that the Cape vulture formed a superspecies with the Eurasian Griffon and Rüppell's vulture. In this classification, the Cape vulture would be a subspecies of *Gyps fulvus* (Stresemann and Amadon 1979; Amadon and Bull 1988). A close relation between *G. coprotheres* and *G. fulvus* was also supported by Wink (1995). This was based on the divergence in nucleotide sequences in the cytochrome b gene. Wink suggested that the two species diverged from a common ancestor about half a million years ago.

Foraging

Cape vultures in Namibia were described as denizens of open habitat such as grassland and open woodland savanna, with the majority (79%) of prey animals being wild ungulates (Schultz 2007). In that study, Greater Kudu (*Tragelaphus strepsiceros* Pallas 1766) were the most common prey item (54.2% of all carcasses) followed by cattle, eland and horses. The Cape vulture is a heavy bird with a high wing loading (112 N/m). It practices fast cross-country soaring (Pennycuick 1972). In this it contrasts with the commoner, smaller White-backed vulture in Namibia (a lighter bird with a wing loading of 76 N/m) (Pennycuick 1972; Bridgeford 2004). Possibly the White-backed vulture may have evolved in the denser wooded savanna, and hence is more adapted to bush encroachment than the Cape vulture, which may favor a more open grassland (Brown 1985; Schultz 2007). The White-backed vulture frequents alpine grassland, followed by moist woodland, sour grasslands, arid woodland, and mixed and sweet grasslands (Mundy et al. 2007).

The Cape vulture is the only vulture in southern Africa south of 28° and thus has little foraging competition (Mundy et al. 2007). North of this area it is in competition with four other species: the common White-backed vulture, the Hooded vulture, the Lappet-faced vulture and the White-headed vulture.

Breeding

The Cape vulture is a colonial cliff-nester (Bamford et al. 2007; Schultz 2007). Some individuals nest in trees (Bamford et al. 2007). Breeding usually starts in April to June, with the laying of one egg (Fig. 1.6d), with fledging between the end of October and mid-January. Juveniles normally remain in the vicinity of the colony until the following breeding season, followed by dispersal to start their own breeding some six years later (Pickford 1989; Mundy et al. 1992; Piper 1994; Hockey et al. 2005; Boshoff and Anderson 2006).

Population status

The distribution of the Cape vulture is shown in Fig. 1.6e. This species has been declining across its range (Monadjem et al. 2004; Shultz 2007). For example, in Namibia its range declined precipitously after the Second World War. All its known breeding colonies and roosts were abandoned, except for a handful of individuals by the 1990s (Mundy and Ledger 1977; Collar et al. 1994; Simmons and Bridgeford 1997; Simmons 2002). The incidence of the rinderpest disease was a factor for this decline (1886–1903) which killed many herbivorous animals, including domestic cattle. Other factors were the Anglo-Boer War, the destruction of game herds, the replacement of wild ungulate herds with domestic stock, the conversion of grazing land to cultivation and poisoning (Boshoff and Vernon 1980). Recent threats include electrocution and collision with power lines, persecution, killings for traditional medicine, drowning in farm reservoirs and human disturbances (Anderson 2000; Monadjem et al. 2004).

Bush encroachment after 1950 is a factor for the decline in the range of the Cape vulture (Schultz 2007). This involves the conversion of grassland and woodland savannas to dense acacia-dominated vegetation with minimal grass cover (Barnard 1998; Muntifering et al. 2006). This may result from changes in the incidence of bush fires and increased grazing pressure on grass (Ward 2005). There is no clear evidence that bush encroachment negatively affects vultures (Smit 2004). However, Schultz (2007) argues that it may reduce the visibility of carcasses for foraging vultures in dense bush (Houston 1974; Mundy et al. 1992). In some other studies, however, vultures have been recorded as finding non-visible food by following other avian scavengers such as the Bateleur eagle, Milvus kites, corvids and jackals (Mundy et al. 1992; Camina 2004). Bush encroachment may also indirectly reduce the livestock stocking rates and affect food sources (Bester 1996; Dean 2004; Smit 2004) which in turn may affect scavenger bird populations (Schultz 2007). Satellite image-based studies have shown that vultures prefer commercial farmland to communal areas or the protected Etosha National Park (Mendelsohn et al. 2005).

Vulture numbers in Botswana peak between protected and grazing land, as the birds may breed and roost inside conservation areas and feed on livestock in non-protected areas (Herremans and Herremans-Tonnoeyr 2000). This strategy is also observed among Griffon vultures *Gyps fulvus* in Israel (Bahat 1995; Schultz 2007).

1.7 Griffon vulture (*Gyps fulvus*, Hablizl 1783)

Physical appearance

The Griffon vulture, also called the Eurasian Griffon vulture or Common Griffon vulture is a large to very large vulture, and very closely related to the Cape Griffon vulture when molecular phylogeny of the mitochondrial cytochrome b (cyt) gene is used (Wink 1995). The Griffon vulture is one of only a few vulture species resident in Africa, Asia and Europe; the others are the Bearded vulture *Gypaetus barbatus*, the Cinereous vulture *Aegypius* *monachus* and the Egyptian vulture *Neophron percnopterus* (Houston 1983; Mundy et al. 1992; Clark 2001).

The body length and tail is 93–122 cm (37–48 in), while the wingspan ranges from 2.3 to 2.8 m (7.5–9.2 ft). Males usually weigh 6.2 to 10.5 kg (14 to 23 lbs) and females about 6.5 to 11.3 kg (14 to 25 lbs). This species has a yellow bill and white neck ruff. The buff body and wing coverts contrast with the dark flight feathers (Ali 1996; Ferguson-Lees and Christie 2001) (Fig. 1.7a,b,c).

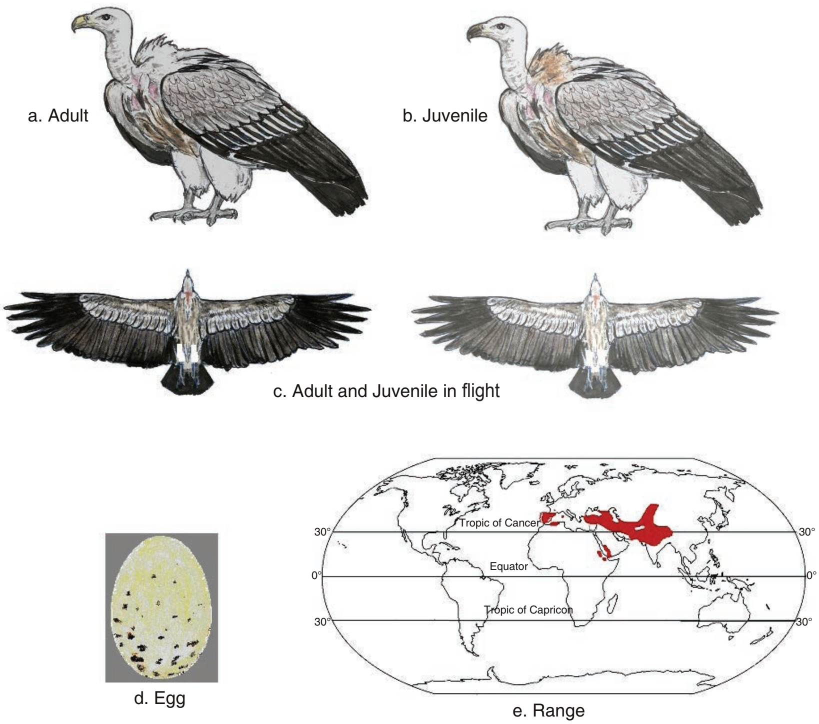

Fig. 1.7. Griffon vulture.

Classification

There are currently two recognized subspecies: *Gyps fulvus fulvus* and *Gyps fulvus fulvescens*. The former is found in Spain, Southern France and Morocco, eastwards to the eastern Mediterranean. The latter is found in northern India, north into Kyrgyzstan, Russia and the western Himalayas. Johnson et al. (2006: 66) note that their study represents the 'first attempt