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FAO ANIMAL PRODUCTION AND HEALTH PAPER

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Food and Agriculture Organization of the United Nations

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Part I
A review
by
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Part II
Case studies
by
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Part I - A review

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Introduction

OSTRICH (Arabic *na-ama*, French *autruche*, German *Strauß*, Italian *struzzo*, Norwegian *struts*, Spanish *avestruz*)

The ostrich aroused the imagination of the ancients from the earliest times onwards. From antiquity, ostriches have provided human beings with food, clothing, utensils and adornment; they have also been persecuted for their meat, skin, feathers and eggs. The latter, in particular, have long been prized. Eggs were traded all over the Mediterranean. An ostrich egg with animal paintings was found in the Isis Grotto at Vulci, in Italy, and silver and gilt eggs were imported by the Etruscans. In ancient Sparta, an egg was on exhibition which, apparently, Leda had laid following her affair with Zeus in the shape of a swan and from which the Dioscuri had hatched. The Bushmen, and later European sailors, found that ostrich eggs were an invaluable source of food that kept fresh for long periods. The Hottentots used whole empty shells as practical water vessels, and shell fragments have been made into beads for necklaces. Carved vases and cups of ostrich eggshells were used in ancient Egypt and Mesopotamia 5 000 years ago and also in post-Renaissance Europe. Eggshells are used to the present day to make necklaces and belts, and to carry water.

In West Africa, ostrich eggs are believed to have magic properties, protecting houses against lightning (see Figure 1). Ostrich eggs on graves in south Ethiopia denote the number of enemies killed by the deceased and they are valued as symbols of ritual and creative forces from West Asia to the Niger in Africa.

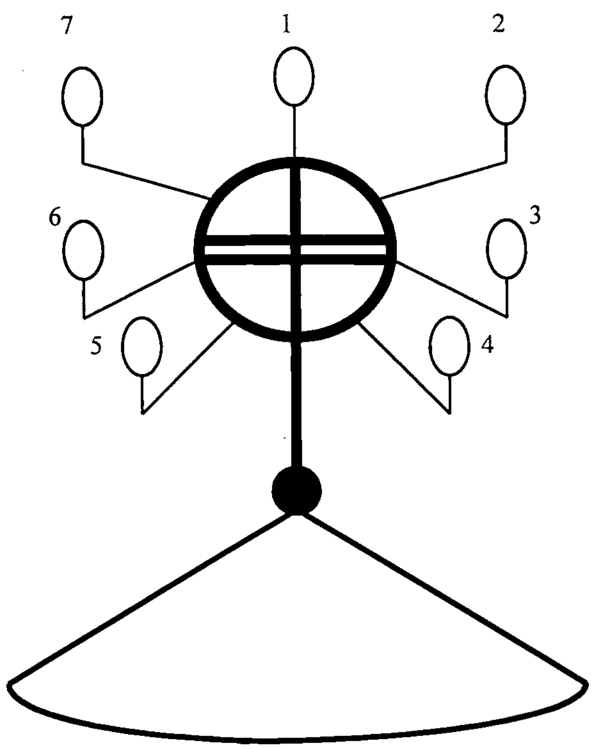
The ostrich also features frequently in prehistoric rock art and folklore, and in the scriptures and earliest written records (Figure 2). In Tutankhamen's tomb, there is a depiction of the king hunting ostriches with a bow and arrow from his chariot; this was apparently a privilege of the Pharaohs. The capture of ostriches is depicted in the mosaic of the corridor of the great hunting scene in the famous fourth-century villa of Piazza Armerina in Sicily.

Apart from being hunted for their flesh, skin and plumes, ostriches were kept in captivity and tamed by the early Egyptians, Greeks and Romans (Figure 3). Captive birds were fattened for the table, and noble Egyptian and Roman ladies rode ostriches on ceremonial occasions. The ostrich was shown in the circus in Rome. The second-century Roman Emperor Commodus had the heads of ostriches cut off, and the public was kept entertained as the birds ran around frantically before eventually collapsing. Occasionally, ostriches were used for pulling small carts. In processions, Ptolemaeus Philadelphus used a chariot drawn by eight ostriches. His queen had a statue showing her riding an ostrich. The eccentric Roman Emperor Heliogabalus of the third century had 600 ostrich brains served at a banquet.

Ostrich feather plumes have been used for decoration for many generations. They adorned the fans of the Assyrian kings and popes, the horses of the Pharaohs' chariots and the head-dresses of Greek, Roman and Turkish generals. They are still common in the head-dress of African warriors. Ostrich plumes are frequently featured in the hieroglyphics of ancient Egypt where, because of their symmetry, they were adopted as symbols of justice and truth. Unlike the feathers of other birds, the barbs of the ostrich feather are equally divided on both sides along the central shaft.

FIGURE 1
A seven-pointed star with an ostrich egg on each of the exposed points

(1- Truth, 2- Benevolence, 3- Brotherly love, 4- Harmony, 5- Sprint, 6- Justice, 7- Peace)



During the seventeenth century, a few unsuccessful attempts were made in Europe to rear ostriches for their meat. Undoubtedly, however, human long-standing fascination with ostrich feathers as an article of decoration was the foundation block for the bird's domestication. The wearing of ostrich plumes, as high-fashion attire, was particularly promoted by Marie Antoinette in France during the second half of the eighteenth century. Until the nineteenth century, all ostrich feathers supplied to Europe were obtained from wild birds hunted and killed in North Africa and Arabia.

The ever-growing increase in popularity of ostrich feathers in the fashion world during the first half of the nineteenth century, coupled with the decline of the ostrich in the wild, prompted the Acclimatization Society of Paris in 1851 to offer premiums for the successful domestication of ostriches in the French colonies, and for breeding them in Europe. The first successful response to this offer was achieved only in Algeria in 1856. At the same time, however, independent attempts at domestication were taking place in South Africa. Subsequently, ostrich farming was experimented in Asia, Australia and in both North and South America.

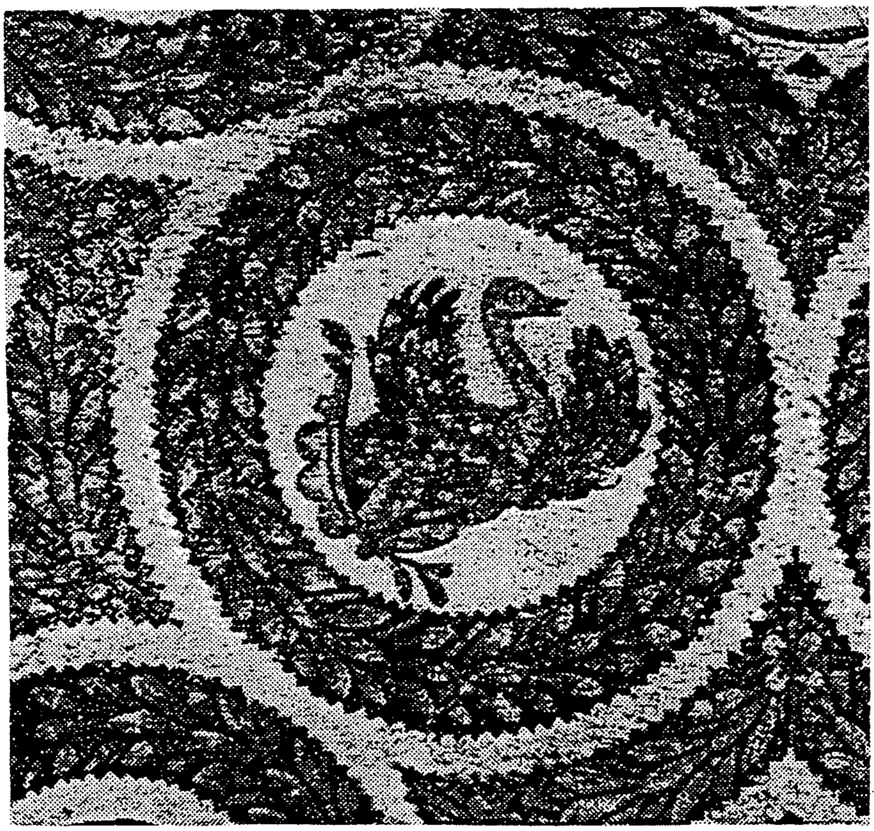
FIGURE 2
A billon tetradrachm of Antoninus Pius (144 AD) of the Alexandria mint

Although ostriches were greatly reduced in number towards the last half of the nineteenth century and were threatened both by increasing direct persecution (a large number of ostriches were shot in South Africa following the discovery of diamonds in an ostrich gizzard) and by destruction of their habitat through overgrazing, the domesticated population flourished in the Oudtshoorn district of South Africa.

The first commercial ostrich farm was established in South Africa in about 1865 solely for harvesting the feathers every six to eight months. Ostrich farms began to spread gradually to other countries, particularly Egypt, Australia, New Zealand, the United States and Argentina, until the total number of ostriches raised commercially reached more than one million by 1913. The lucrative trade in ostrich feathers (particularly the wing feathers) persisted for about 50 years, until it crashed disastrously with the onset of the First World War in 1914. After the slump, ostrich farming remained depressed, and the number of ostrich farms dropped significantly until the Second World War. The industry, nonetheless, managed to survive on a much smaller scale in South Africa, mainly through a diversification of consumer products. By relying on ostriches not only for their feathers but also for their meat and hide, the industry grew steadily thereafter.

Now there is no part of the bird that is not put to some use, and the whims of high fashion no longer solely determine the success of ostrich farming.

FIGURE 3
Ostrich in a mosaic of the Roman Imperial period



In 1986, just before the economic sanctions, annual export by South Africa of ostrich hides to the United States alone reached a record high of 90 000 hides. The shortage of ostrich skin after 1986 caused prices to rise. This made ostrich farming an attractive proposition and led a number of business enterprises in Europe and particularly in the United States to start ostrich farming in an attempt to meet part of the ever increasing international demand. The world ostrich industry has now finally taken off and its future success seems to be assured.

Chapter 1

Origin and evolution of the ostrich

Five fossil species of ostriches are known, the oldest of which is 50 to 60 million years old (early Tertiary). From the evidence of fossil bone and eggshell fragments, these species of ostrich were generally larger than those of the present day. During the Pliocene and Pleistocene periods (up to five million years ago), they occupied wide areas of China, southern Russia, India, eastern and southern Europe and the Middle East as well as Africa.

The following species have been described from fossil remains:

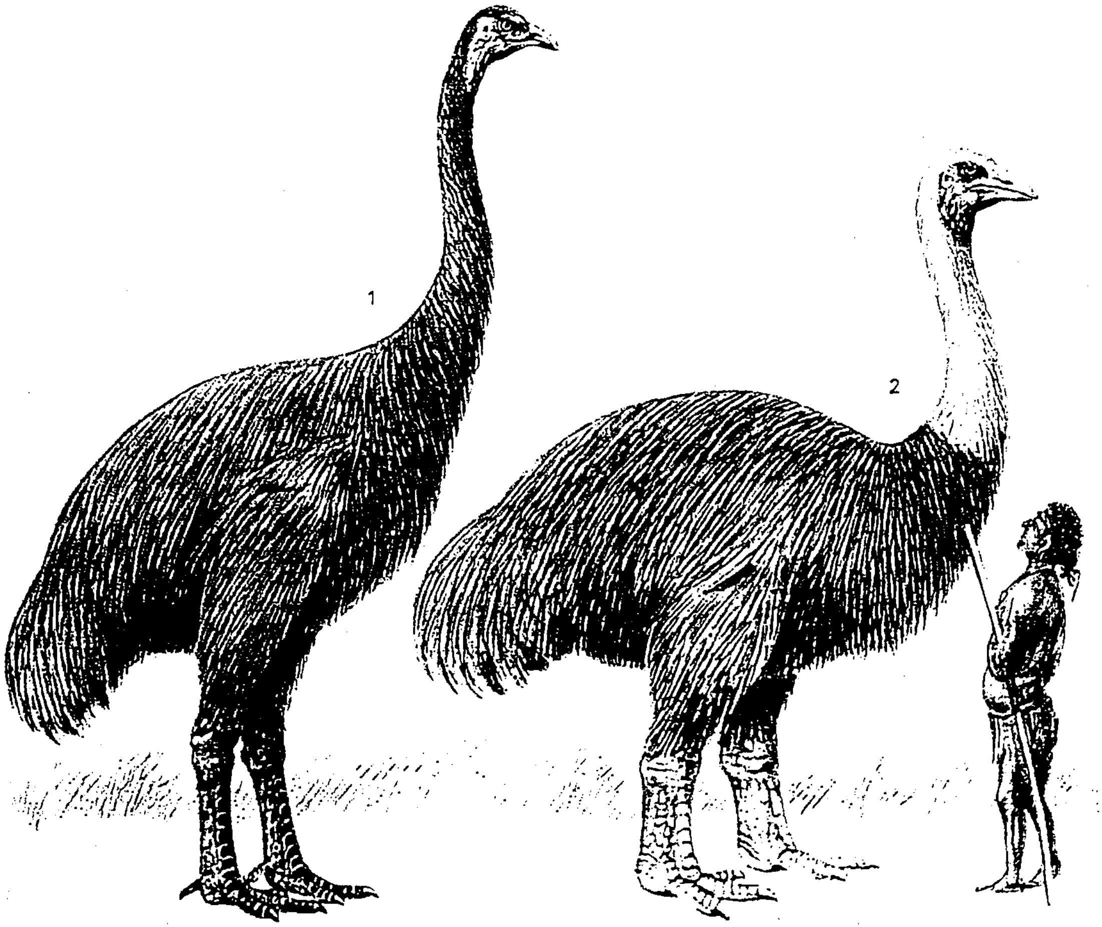
- *Struthio novorossicus* (Alexeiev): described from a tarsometatarsus from the Lower Pliocene beds on the west coast of the Black Sea.
- *S. karatheodoris* (Forsyth Major): described from bones of Lower Pliocene found on the island of Samoa.
- *S. odlawayi* (Lowe): remains have been found in Algeria (Tertiary), in Egypt (Late Pleistocene or Recent) and in East Africa (Lower Pleistocene).
- *S. asiaticus* (Milne-Edwards) and *S. indicus* (Bidwell): described from egg fragments found near the Kain River in India (Lower Pliocene).
- *S. wimani* (Lowe): described from a pelvis found in Lower Pliocene at T'ai Chia Kau in Pao Te Hsien, North West Shansi on the Yellow River, China.

The above species were much larger than existing ostriches. It is of interest to note that there is a remarkable resemblance between ostriches and the extinct Elephant birds of North Africa and Madagascar (family Aeopyornithidae, genus *Aepyornis*). Remains of the Elephant bird up to 60 million years old have been found in Tertiary rocks of North Africa. The skeletons of Elephant birds are well documented and must have resembled the ostrich in life. The head was small, the wings were reduced to mere vestiges and the legs were long and powerful and used for running. The largest species, *A. maximus,* attained a height of well over 3 m (see Figure 4), and probably inspired several of the legends of the past (such as the roc of Sinbad the Sailor and Marco Polo).

CLASSIFICATION OF THE OSTRICH IN THE ANIMAL KINGDOM

The ostrich (Figure 5) is the only living species belonging to the family Struthionidae (order Struthioniformes). It is the largest of living birds. Like most other flightless birds,

FIGURE 4
The largest Moa (1) and Elephant bird (2). Both birds lived until relatively recent times and may have been seen by primitive humans



it is highly adapted for a terrestrial life, having very long and powerful legs that, together with the elongated neck, make up a considerable part of the bird's height. The male body plumage is black while the more plumy wings and tail are white. The smaller females are duller, with grey-brown plumage. In both sexes, the head looks small in relation to the rest of the bird. Ostriches have unusually prominent eyes (the largest of any terrestrial vertebrate, c. 50 mm in diameter) and long black eyelashes, apart from which the head and most of the neck are almost bare, just sparsely covered with down and bristle-like feathers. The legs are largely bare, while the skin of the neck and legs is greyish or reddish.

The ostrich has only two toes on each foot, the original third and fourth digits, of which the third is the largest. The reduction in the number of toes from the normal five is an adaptation to a predominantly running and walking mode of life, giving greater strength and thrust to the foot (as in the reduction of the horse's foot to one strong digit). Ostriches, with their long necks and keen eyes, are able to see over considerable distances (up to 12-14 km); their powerful legs make them capable of speeds up to 70 km/h (with strides of up to 8 m) so that they can outpace most pursuers. The large inner toe and occasionally the smaller outer toe carry a powerful nail. In addition to locomotion, the legs are used for striking opponents and small predators, for scraping the ground, and for scratching the head.

FIGURE 5
Taxonomic classification of the ostrich in the animal kingdom

ANIMAL KINGDOM

Phylum:	Chordata
Subphylum:	Vertebrata
Class:	Avis (wings and feathers)
Order:	Struthioniformes
Suborder:	Struthiones
Family:	Struthionidae
Genus:	*Struthio*

Species: ***Struthio camelus*** **Ostrich**

Subspecies (races):
S. c. camelus
S. c. molybdophanes
S. c. massaicus
S. c. australis
S. c. syriacus
S. c. spatzi

The species name *Struthio camelus* (given by Linnaeus in 1758) comes from the Greek and Latin name *Struthocamelus*, by which the ostrich was known. The word *camelus* is based on the similarity of the ostrich to camels: long strong legs, long necks, prominent eyes and eyelashes, large size, and remarkable tolerance to the desert habitat.

Ostriches are found in a variety of open habitat. They avoid areas of thick bush or of heavy tree cover and rarely seek shade. They are totally diurnal, sitting down at dusk and remaining inactive throughout the night unless disturbed. They are on their feet for most of the daylight hours, except when dust bathing, resting or nesting. The chicks and juveniles are strictly gregarious (always remaining in compact groups); adults are less so.

Ostriches have a variety of vocalizations, but are normally silent. During the breeding season, territorial males produce a deep booming trisyllabic "ohh-oooh-oooooo", descending in pitch at the end. To attract females or against other males, the call is uttered mainly by day (especially early morning) but occasionally at night and can be audible up to 3 km away. Other calls include a soft "booh" or "twoo", which are possibly contact calls and may also be associated with anxiety and distraction displays. In addition, hoarse guttural calls, "hurp", hisses, beak snapping and stomach rumbling are produced in threat or aggression. Chicks in anxiety or distress utter entirely different, melodious, trilling "quirrrr-quirrrrr" calls.

GEOGRAPHICAL DISTRIBUTION OF RATITES

There can be no doubt that ostriches and other large flightless birds have disappeared from a large part of their range and have been disappearing for perhaps a million years. No reason is apparent. It is possible that ostriches were used as a source of food by human beings and were eventually exterminated through overexploitation. The fact, nonetheless, remains that there are no more ostriches in southern Europe, in India, or in China, where fossil remains have been found. At present wild ostriches are confined to the drier parts of Africa, generally from south of the Sahara to Cape Province, extending also to southern Morocco, the northern Sudan and southern Egypt (Figure 6). Their natural distribution is broken in Central Africa by a belt of *Brachystegia* woodland in the southern part of the United Republic of Tanzania, Zambia and Mozambique.

Ratites are flightless birds (Table 1), which have a flat breastbone, without the keel-like prominence characteristic of most flying birds. The name ratite comes from the Latin *ratis* (raft), a reference to the "keel-less" sternum of the birds. The interrelationships between the ratites have long puzzled zoologists as it is uncertain whether they are a natural group or a mere assemblage of unrelated forms that followed parallel lines of evolution.

Recently, however, it has been stated that ratites are related through a common ancestor (possibly capable of flying), which by successive invasions via the Antarctic before the break-up and migration of the continents into their present global positions, reached its final destination.

FIGURE 6

Natural distribution of the ostrich in Africa

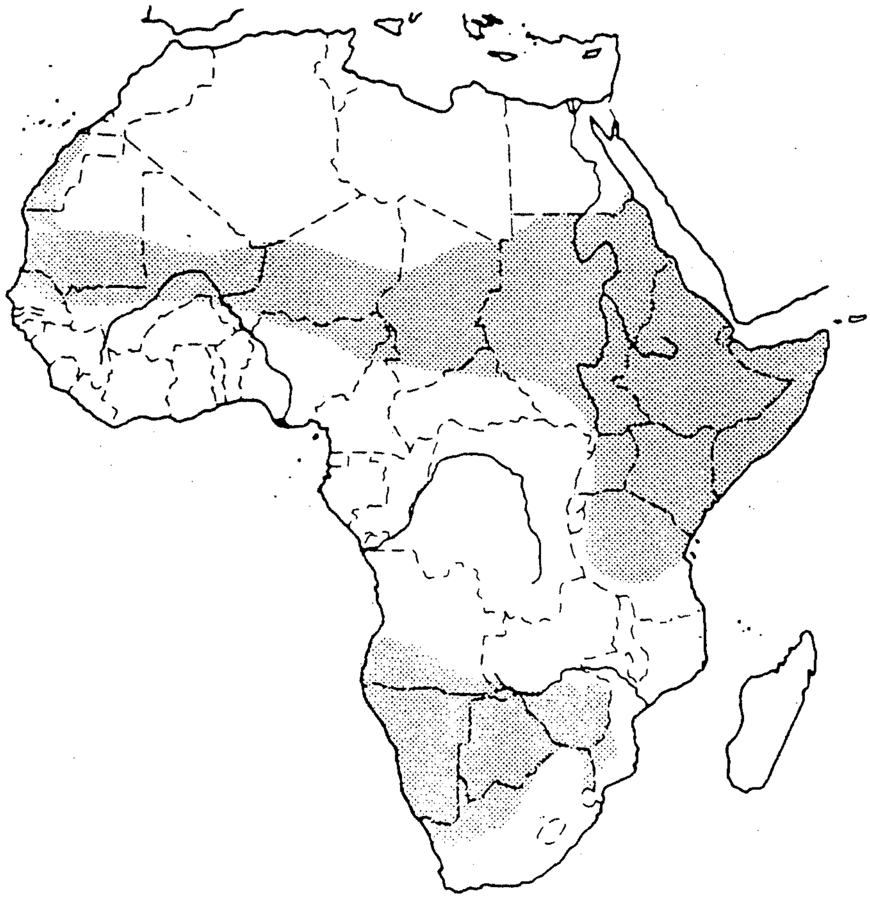


TABLE 1
Classification of ratites

Order Struthioniformes

Family Struthionidae
Struthio camelus - Ostrich
Order Rheiformes
Family Rheidae
Rhea americana - Common or Greater rhea
Pterocnemia pennata - Darwin's rhea
Order Casuariformes
Family Dromaiidae
Dromaius novaehollandiae - Emu
Family Casuariidae
Casuarius casuaris - Australian cassowary (Double-wattled cassowary)
Casuarius unappendiculatus - Single-wattled cassowary
Casuarius bennetti - Dwarf cassowary
Order Aepyornithiformes
Family Aepyornithidae - Elephant bird (extinct)
Order Dinornithiformes
Family Dinornithidae - Moa (extinct)
Family Anomalopterygidae - Anomalopteryx (extinct)
Order Spterygiformes
Family Apterygidae
Apteryx australis - Brown kiwi
Apteryx oweni - Little spotted kiwi

The general characteristics of present-day ratites and their geographical distribution are summarized in Table 2. Further comparisons can be found in later chapters.

OSTRICH SUBSPECIES

There are six geographical subspecies or races of *Struthio camelus*, differing from one another slightly in size, in skin colour of the bare thighs, head and neck, and in the size and texture of their eggs (Table 3).

TABLE 2

General characteristics of ratites

	Ostrich	Common rhea	Darwin's rhea	Emu	Cassowary	Kiwi
Body size						
Height (m)	2.5	1.5	1.0	1.6	1.5	0.4
Weight (kg)	135	25	18	38	38	2
Body-feather colour						
M	Black	Grey	Grey	Grey-black	Glossy black	Tan-brown
F	Grey-brown	Monomorphic	Monomorphic	Monomorphic	Monomorphic	Monomorphic
Toes	2	3	3	3	3	3
Speed (km/h)	70	50	45	50	50	45
Egg colour	Creamy white	Golden white	Light green	Glossy green	Green	Glazed white
Egg wt (kg)	1.5	0.6	0.65	0.6	0.65	0.45
Incubation (d)	42	42	42	58-61	30	75-78
Incubating sex	M/F	M	M	M	M	M
Natural distribution	Africa south of the Sahara	Brazil, Bolivia, Argentina	Peru, Bolivia, Chile, Patagonia	Australia (except east)	NE Australia, New Guinea	New Zealand

The **North African ostrich**, *Struthio c. camelus* (after Linnaeus). Formerly found throughout northern Africa, its current native range is reduced to a band across the African continent from southern Morocco and Mauritania (west) to Awash Valley in northeast Ethiopia and the Omo River in southwest Ethiopia (east); and from the southern Sudan and northern Uganda (south) to southern Egypt and along the Red Sea (north). This is the tallest race, distinguished by a distinct bald crown on the head, ringed with short brown bristly feathers extending down the back of the neck. It has a collar of white feathers between naked neck and lower neck about two-thirds of the way down the neck. The bare neck and thighs are bright pink in colour. The male wing and tail-feathers are pure white, the lower mandible is red, the eyes brown and legs reddish with brighter red tarsal scales. The female body feathers are dark brown with paler wing- and tail-feathers. In the breeding season, the neck and bill of the male become brighter red; tarsal scales are also brighter.

The **Somali ostrich**, *Struthio c. molybdophanes* (after Reichennow). Its natural range overlaps slightly with the North African ostrich, extending from northeast Ethiopia (north) down across Somalia to northeast Kenya (south). The crown is bold like *S. c. camelus*, but it has a broad white neck ring. The bare skin of the neck and thighs is blue-grey rather than pinkish. The tail feathers are white. The body plumes of the male are strikingly black and lighter grey in the female. The females of this subspecies are rather larger than the males.

The **East African** or **Masai ostrich**, *Struthio c. massaicus* (after Neumann). Found in East Kenya from south of Tsavo (east) to south Samburu District (west) and to Katavi grasslands in the United Republic of Tanzania (south). The crown of the head may be partially bald or completely feathered. The bare skin of the neck and thighs is pinkish-grey, flushing bright red when in breeding. There is a narrow white neck ring. The wing and tail feathers are white.

The **South African ostrich**, *Struthio c. australis* (after Gurney). Its original range extends from Zimbabwe-Botswana, Namibia to Cape Province in South Africa. The crown is feathered. The neck is grey, flushing red when in breeding, along with the tarsal scales. The tail feathers are not white but dull brown to bright cinnamon-brown. There is no white ring on the neck. With adult males weighing up to 150 kg, this race is possibly the heaviest.

TABLE 3
Summary of essential differences between adult ostrich subspecies

	N. African	Somali	E. African	S. African
Crown	Bald	Bald	Partly bald	Feathered
White neck ring	Narrow	Broad	Narrow	No ring
Neck colour	Reddish	Blue-grey	Pink-grey	Grey
Thigh colour	Reddish	Blue-grey	Pink-grey	Pinkish
Male tail-feathers	Pure white	White	White	Light brown
Eyes	Brown	Grey	Brown	Greyish brown
Female feathers	Dark brown	Light grey	Brown-grey	Brown-grey
Height (m)	2.5-3.0	2.0-2.5	20.-2.5	2.0-2.5
Size (kg)	90-130	80-120	90-130	100-150
Female to male	Smaller	Larger	Smaller	Smaller

The **Arabian ostrich**, *Struthio c. syriacus* (after Rothschild). A distinct race that is now extinct, it was formerly found in Sinai, in the Syrian Arab Republic and the Arabian deserts from the Euphrates Valley at about 34° N and from the Jordanian-Saudi border at Wadi Sirhan to the central Nafud desert eastward to the Persian Gulf and southward to the coast in the vicinity of Bahrain. Rather smaller than the African races, the Arabian ostrich had superior feathers. This race was ruthlessly hunted for its plumes and, with the advent of the car, was even pursued and shot for "sport". Because of the ready market for this bird and the poverty of the local people at the time, the extermination of the Arabian ostrich was extremely rapid. It was seldom seen after the mid-1940s anywhere in its former range. The last authenticated Arabian ostrich was shot in Bahrain around 1956.

The **Rio de Oro** or **Dwarf ostrich**, *Struthio c. spatzi* (after Stresemann). Normally confined to the Rio de Oro region of northwest Africa, this subspecies was described from eggs that have pores shaped like "a short straight comma". However, the distinction was made largely on the grounds of its somewhat smaller size. It is now merged with the North African ostrich and is no longer recognized as a distinct subspecies.

Ostriches have sometimes been split into two or even four subspecies on the basis of whether the crown is bold or feathered, the colour of the neck (Table 4) and egg-pore characteristics (see Table 5).

TABLE 4
Commercial classification of ostrich subspecies

Commercial name	Subspecies
Red-necked	*Struthio c. camelus*
	Struthio c. massaicus
Blue-necked	*Struthio c. molybdophanes*
	Struthio c. australis

It is not easy to recognize the differences among the various subspecies until the ostriches are about two years of age. Moreover, the different subspecies will successfully interbreed and produce fertile offspring.

The **Domestic ostrich**, *Struthio c. domesticus*. This is technically a variety and not a subspecies. The terms "African black" or "Black-necked ostrich" were recently coined by American ostrich farmers as trade names and therefore are not officially recognized. The old terms "Cape ostrich" or "Cape feather bird" describe an ostrich reared in the Cape colonies of South Africa for feather production and are still currently used. The Domestic ostrich (which is technically a correct term), is genetically a hybrid of several wild subspecies; the foundation stock is the captive South African ostrich (*Struthio c. australis*). During the late nineteenth century and early twentieth century, several shipments of North African (*Struthio c. camelus*) and Arabian (*Struthio c. syriacus*) ostriches were brought to South Africa and selectively bred with *Struthio c. australis* in order to improve feather quality. Ironically, the most intensive selection for feather quality took place after the sudden collapse of the feather trade in 1914. Only the finest feathered birds were retained to serve as the foundation population leading to today's Domestic ostrich.

TABLE 5
Egg-pore characteristics of ostrich subspecies

Subspecies	Characteristic
Struthio c. camelus	Eggs large - not so highly polished
Struthio c. molybdophanes	Eggs closely pitted - pits large
Struthio c. massaicus	Eggs with pitting more scattered - pits large
Struthio c. australis	Eggs closely pitted - pits small
Struthio c. syriacus	Eggs small - highly polished

The Domestic ostrich maintains the appearance of the original blue-necked *Struthio c. australis*. Compared to the wild subspecies, however, it is generally smaller with proportionally shorter legs and neck, and frequently a shorter mandible (bill). The distinguishing characteristic is feather quality. Individual barbs are broader, by as much as 1 cm, than those of the wild type and rounded at the tip rather than pointed. Furthermore, adult females of the Domestic ostrich have a greater proportion of white plumes.

Chapter 2

Basic anatomy and physiology of the ostrich

Veterinarians dealing with medical and surgical problems or propagation management of this unique flightless bird should have a basic understanding of ostrich anatomy to handle the birds safely and to understand how to collect laboratory samples, administer medication, evaluate radiographs, perform surgery and distinguish between normal and abnormal tissues at necropsy.

This chapter aims to provide the reader with the main anatomical differences between the ostrich and other avian species. The musculoskeletal, digestive and reproductive systems will be emphasized because of their importance in clinical medicine and in the management of these birds.

INTEGUMENTARY SYSTEM

Ostrich feathers have no barbules to stabilize the filaments attached to the central shaft (rachis), thus they seem more like hair than feathers. They are distributed uniformly over the surface of the skin but are restricted to feather tracts (pterylae). The massive thighs are devoid of feathers. Like other birds, ostriches have no sweat glands.

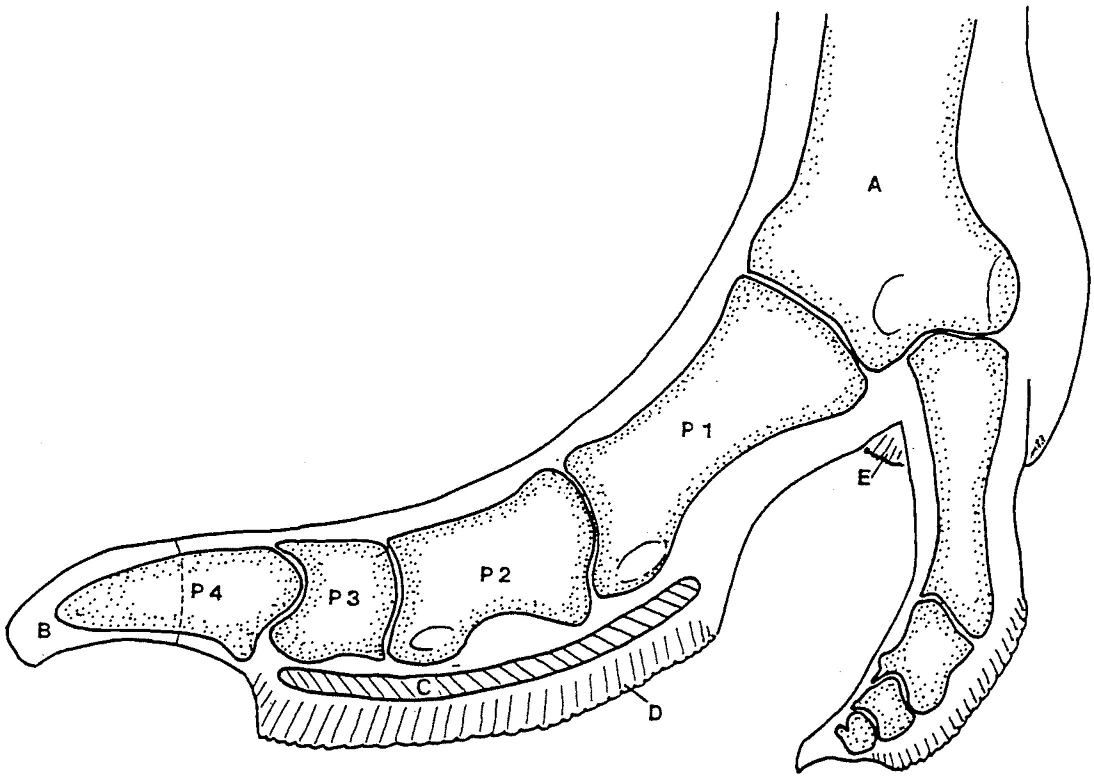
The ostrich has several callous pads. These callosities are dermal thickenings at strategic locations of wear or pressure. Ostriches mainly sit fully sternally recumbent or poised (resting) on the tarsometatarsus. When doing so, the proximal end of the metatarsal bone is protected by a plantar metatarsal pad about 1 cm thick and 5 x 12 cm in size. Prominent callosities are located over the most ventral part of the sternum (1 x 8 x 11 cm) and over the bony prominence produced by the ventrad and carniad projection of the pubic bones (1 x 4 x 9 cm). These callosities bear the bird's weight when in sternal recumbency.

The skin on the dorsoplantar aspect of the tarsometatarsus (shank) and the dorsum of the digits consists of large cornified nonimbricated scutes (scales). Smaller cancellate scutes cover the remainder of the skin surface in these areas.

Another skin modification arises on the plantar surface of the digits (toes). The dermal pad in the ostrich is thick and the epidermal surface is covered with tightly packed vertical rods (0.8 cm long) of cornified pads. This pad of tissue (1 cm thick) averages 6 x 18 cm on the main toe and 5 x 11 cm on the small lateral toe. There is another pad over the tarsometatarsal-phalangeal articulation. Additional cushioning is provided by paired tubular deep plantar fat bodies (1.5 x 13 cm) enclosed by a fibrous capsule (see Figure 7). This tissue is similar to the digital cushion of horses or the bulb of the heel of goats and sheep.

FIGURE 7
The structure of the ostrich foot (*Source*: Fowler, 1991)

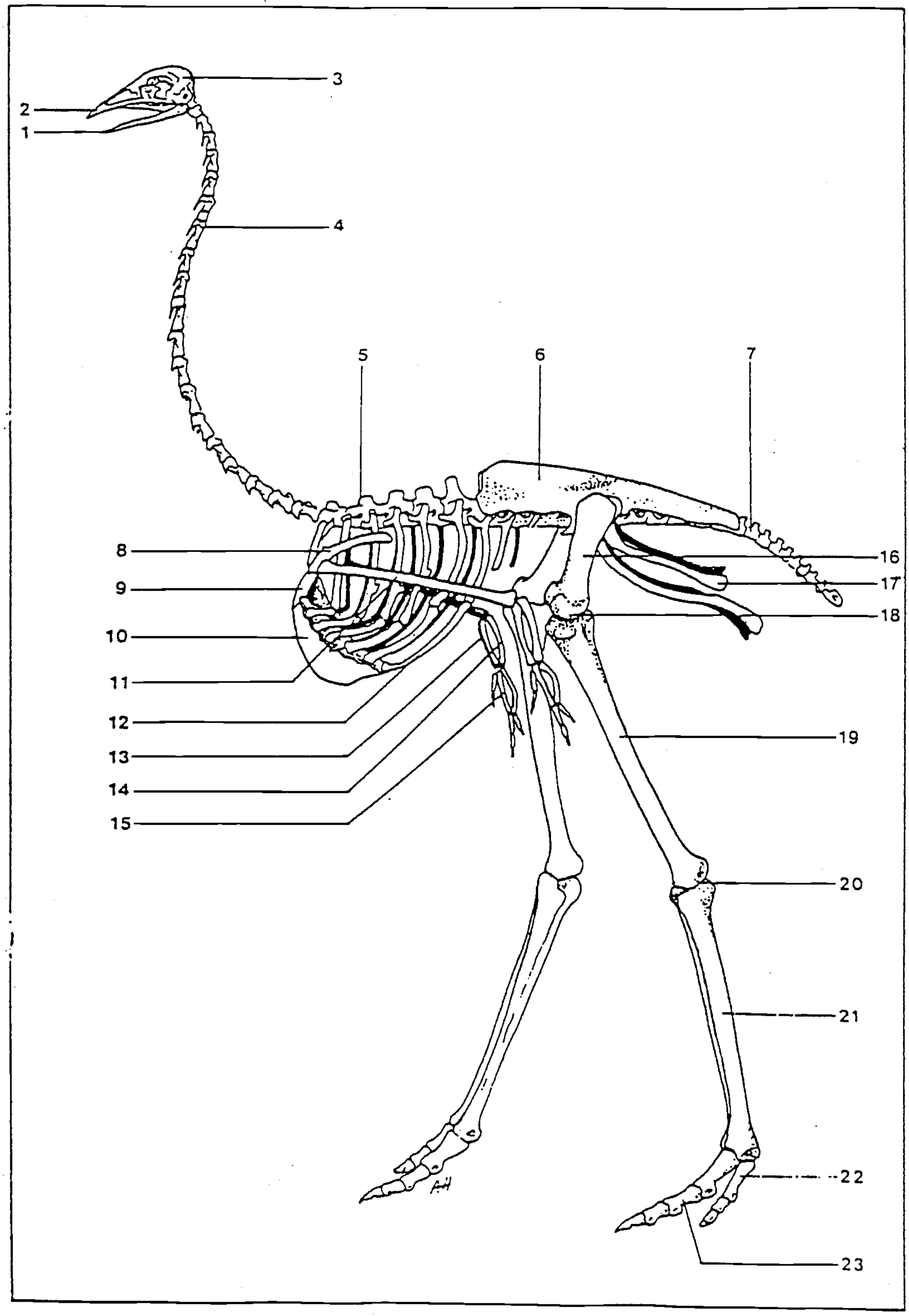
A. tarsometatarsal; B. toenail; C. digital cushion; D. phalangeal pad; E. metatarsal phalangeal pad; P1-4. phalangeal bones



The largest digit of the ostrich has a large blunt toenail. The toenail on the small digit is less well formed. On the wing, the tip of the alula is cornified to form a hook; a similar hook can be found on the distal phalanx.

FIGURE 8
The ostrich skeleton

1 mandible; 2 pre-maxilla; 3 carnium; 4 cervical vertebrae (19); 5 thoracic vertebrae; 6 synsacrum; 7 caudal vertebrae; 8 scapula; 9 evoluted clavicle; 10 sternum; 11 humerus; 12 ribs; 13 radius; 14 ulna; 15 metacarpus; 16 femur; 17 ischium; 18 stifle; 19 tibiotarsus; 20 hock; 21 tarsometatarsus; 22 fourth toe bone; 23 third toe bone

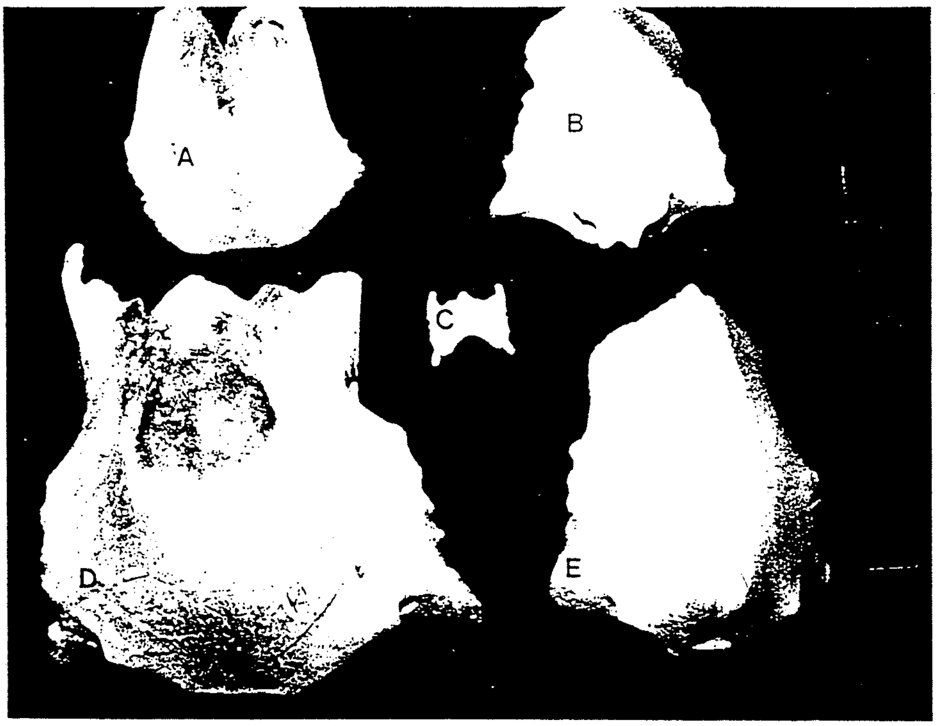


SKELETAL SYSTEM (Figure 8)

The unique sternum gives the name ratite to this group of birds. The sternum is a broad bone, concave dorsally and convex ventrally, rather like a soup plate, which shields the internal organs of the thorax (Figure 9). There is no keel, and the ventral surface is devoid of muscles. The thoracic girdle is modified because there is no need to support flight. The scapula, coracoid and clavicle bone are fused in the adult ostrich, and attached to the cranial sternum (Figure 10).

FIGURE 9
Sternum of ratites (*Source*: Fowler, 1991)

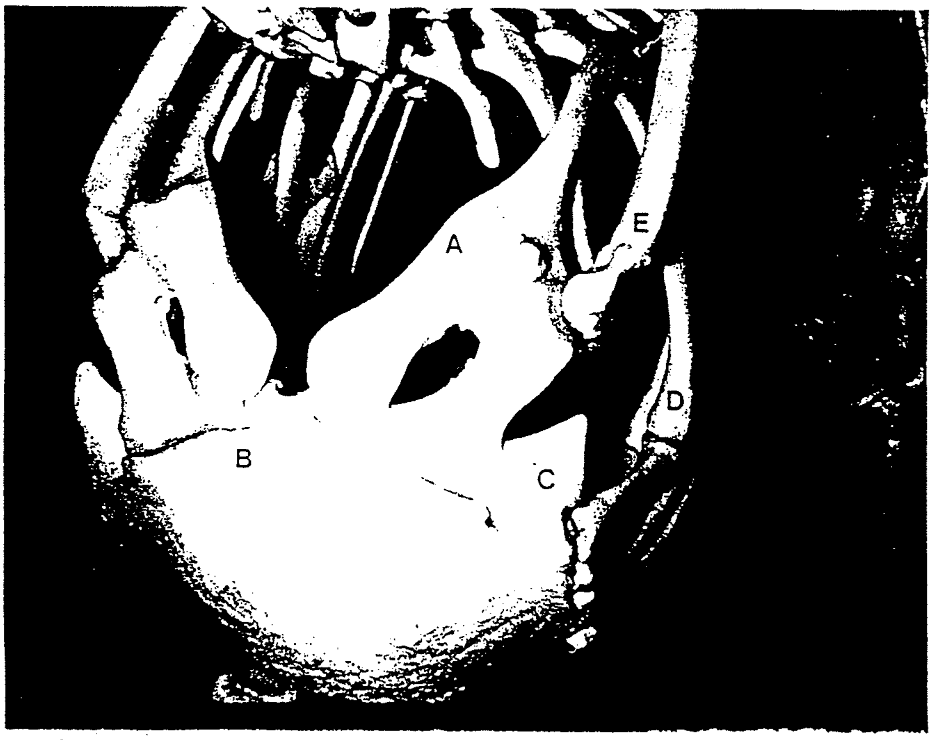
A. rhea; B. emu; C. kiwi; D. ostrich; E. cassowary



The pelvic girdle is characterized by ilia that form an inverted osseous shield over the top of the fused vertebrae (synsacrum). The ischial and pubic bones project caudad to fuse and then turn ventrad and craniad to form a pubic symphysis (Figure 11). In other ratites, the ischial and pubic bones are separate and there is no pubic symphysis. Limb bone measurements are given in Table 6.

FIGURE 10
Thoracic girdle and sternum of the ostrich (*Source*: Fowler, 1991)

A. fused coracoid and scapula; B. sternum; C. cartilaginous extension of the sternum; D. rib; E. humerus



The patella is absent in the ostrich. In its place, there may be a small bone in the tendon of insertion of the muscle on the cnemial crest of the tibiotarsus. This crest provides extra leverage for quick, sure forward movement of the leg in running and swimming birds. The tibiotarsal-tarsometatarsal articulation may be confused with the stifle. One of the tarsal bones in the ostrich remains unfused to the contiguous bones, and its location gives the appearance of a patella.

The ostrich has two digits (3 and 4), while other ratites have three (2, 3 and 4). There are four phalanges on each digit, which is different from other ratites.

TABLE 6
Bone size (cm) in adult ostriches and rheas

Bone	Ostrich	Rhea
Humerus	2.5 x 39	1.5 x 30
Radius	0.8 x 13	0.4 x 21
Ulna	1.5 x 13	0.8 x 21
Metacarpus	9	6
Sternum	25 x 28	-------
Femur	4.5 x 6.5 x 34	2.5 x 20
Tibiotarsus	3.0 x 4.0 x 55	2.0 x 34
Fibula	----------- Fused to tibia	---------------
Tarsometatarsus	3.0 x 3.0 x 47	2.5 x 32
Phalanges		
P-1	11	4
P-2	7	2.5
P-3	3	1.5
P-4	1	1.0

Source: Fowler, 1991.

At hatching, all long bones contain large cartilaginous cones that are continuous with the growth plates and the osseous cortex. At one week of age, ossification commences on the periphery of these embryonic cones, and in some bones the cones become separated from the growth plates. At three weeks of age, the embryonic cones of cartilage can still be seen in the proximal and distal tibiotarsi; narrow cartilaginous bridges connect the cones to the growth plates. In other precocial species, such as chickens and turkeys, the cones of the embryonic cartilage of their long bones at hatching persist in the tibiotarsi until one to two weeks of age only. The presence of large cones of embryonic cartilage at three weeks of age in ostriches (and other ratites) is a normal feature of the developing bone. As these embryonic cones can be mistaken for significant lesions, it is important to be aware of this feature in order to make the correct differential diagnosis of the prevalent musculoskeletal disorders of young ostriches.

FIGURE 11
Pelvic girdle of an adult ostrich (*Source*: Fowler, 1991)

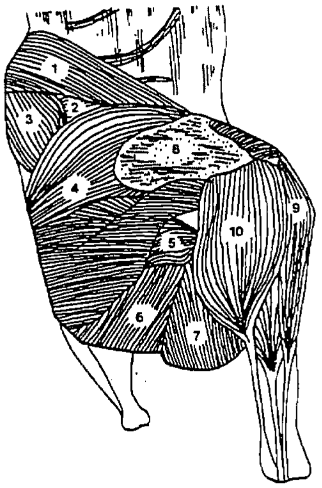
A. femur; B. synsacrum; C. ischium; D. pubic bone; E. pubic symphysis

MUSCULAR SYSTEM

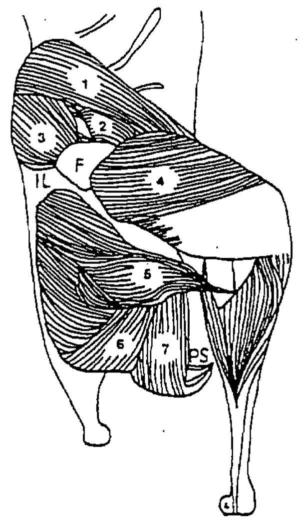
The ventral midline area of the abdominal wall consists of aponeuroses of the abdominal muscles. There is no muscle tissue for 19 cm on either side of the linea alba in the ostrich. Muscle fibres are found only dorsally; the ventral abdomen is supported by a tunic.

It is perhaps of interest to note that the tendons of the ostrich's massive leg muscles (Figure 12) do not ossify as in turkeys.

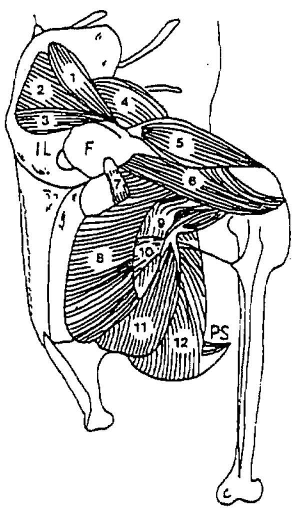
FIGURE 12
Muscles of the pelvic limb of the ostrich (*Source*: Mellet, 1994)



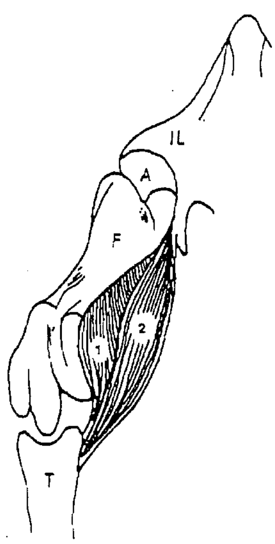
Muscles of the superficial layer of the pelvic limb of the ostrich, lateral view of the right leg
1 *M. iliotibialis cranialis* 2 *M. ambiens* 3 *M. iliofemoralis externus* 4 *M. iliotibialis lateralis* 5 *M. iliofibularis* 6 *M. flexor cruris lateralis* 7 *M. obturatorius medius* 8 *M. femorotibialis medius* (covered by fascia of 4) 9 *M. fibularis longus* 10 *M. gastrocnemius*



Muscles of the second layer of the pelvic limb of the ostrich, lateral view of the right leg
1 *M. iliotibialis cranialis* 2 *M. ambiens* 3 *M. iliofemoralis externus* 4 *M. femorotibialis medius* 5 *M. iliofibularis* 6 *M. flexor cruris lateralis* 7 *M. obturatorius medialis* IL ilium F femur PS pubic symphysis



Muscles of the third and fourth layers of the pelvic limb of the ostrich, lateral view of the right leg
1 *M. iliotrochantericus cranialis* 2 *M. iliofemoralis internus* 3 *M. iliotrochantericus caudalis* 4 *M. ambiens* 5 *M. femorotibialis accessorius* 6 *M. femorotibialis externus* 7 *M. ischiofemoralis* 8 *M. iliofemoralis* 9 *M. pubo-ischio-femoralis* 10 *M. flexor cruris medialis* 11 *M. flexor cruris lateralis* 12 *M. obturatorius medialis* IL ilium F femur PS pubic symphysis



Medial muscles of the upper leg of the ostrich, cranial view of the right leg
1 *M. femorotibialis internus* 2 *M. pectineus* IL ilium A acetabulum F femur T tibia

DIGESTIVE SYSTEM

The tongue of the ostrich is blunt and folded back over itself rostrally, forming a pouch or pocket. The oesophagus generally traverses the right side of the neck, but all cervical structures are movable. It is markedly wide in diameter and when contracted contains numerous longitudinal rugae. The surface of the oesophagus has a cornified appearance.

Comparative measurements of the gastrointestinal tract of some ratites are presented in Table 7. It is of great importance to note that the crop is absent in all ratites. The oesophagus enters the stomach (proventriculus) within the thoracic cavity. The proventriculus of the ostrich is a large, dilated, thin-walled structure. It is also important to note that, in contrast with most other birds in which the entire inner surface of the proventriculus secretes digestive enzymes, the enzyme/acid secretory function in the ostrich is restricted to a patch on the greater curvature (see Figure 13). This glandular area of the proventriculus measures 1 x 5 x 24 cm in the ostrich, only 25 percent of the total inner surface area of the proventriculus, and contains some 300 glands that secrete hydrochloric acid and the enzyme pepsin.

TABLE 7
Comparative measurements (in cm) of the gastrointestinal tract of some ratites

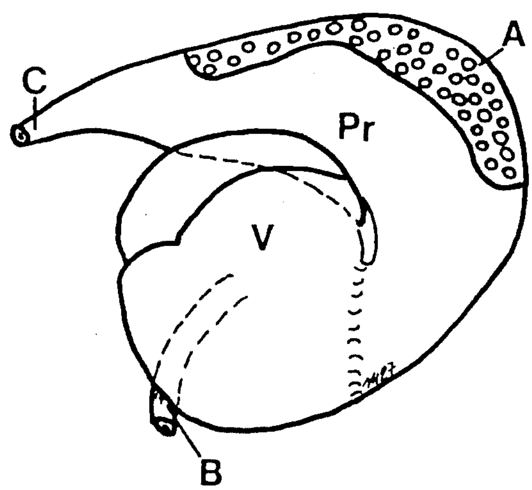
	Ostrich	Rhea	Emu
Proventriculus	14 x 32	4 x 4 x 8	3 x 6 x 8
Ventriculus	12 x 16	9 x 9 x 17	4.5 x 6.5 x 10
Small intestine	640	140	287
Duodenum	80	--------	--------
Jejunum	160	--------	--------
Ileum	400	--------	--------
Large intestine			
Caecum	4 x 94	3 x 48	2 x 9
Rectum	6 x 800	3 x 40	3 x 25
Liver weight (kg)	2.2	--------	-------
Gall bladder	Absent	1 x 5	2 x 8

Source: Fowler, 1991

The distal end of the proventriculus passes dorsal to the ventriculus (gizzard). The opening between the proventriculus and ventriculus is large enough to make it possible to extract any foreign bodies in the ventriculus via an incision in the proventriculus. The entriculus of the ostrich is a thick-walled structure similar to the ventriculus of seed-eating birds. It is situated slightly to the left of the midline at the caudal border of the sternum (Figure 14). Although both the proventriculus and ventriculus may normally contain small stones, impaction is common, particularly in juveniles.

FIGURE 13
Stomach of the ostrich (*Source*: Fowler, 1991)

A. glandular area of the proventriculus; B. duodenum; C. oesophagus; Pr. proventriculus; V. ventriculus



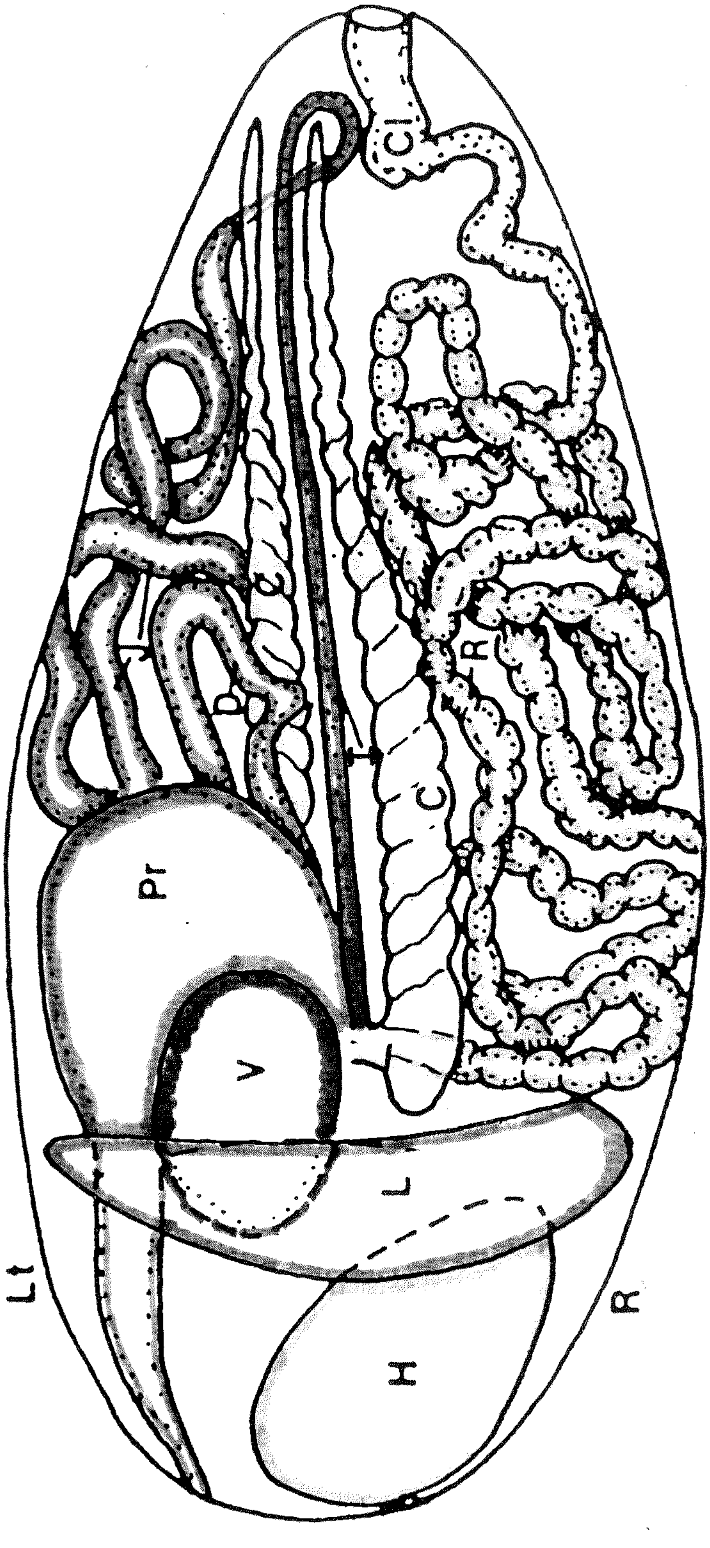
The dark tough lining (koilin) of the proventriculus and ventriculus is formed by protein secreted from the glands combined with entrapped sloughed cells and cellular debris. The greenish or brownish colour arises from refluxed bile pigments from the duodenum.

A duodenal loop is formed, with the pancreas lying between the segments. There is a secondary duodenal loop in the ostrich and the folds of the small intestine occupy the left mid-to-caudal abdomen. The small intestine is relatively short and straight. The ileum is located within the mesenteric attachment between the paired caeca and enters the large intestine at an ileo-caeco-rectal junction. In the ostrich, upon initial incision of the ventral midline abdominal wall, the elongated caeca are visible, and course diagonally from right to left in a caudal direction. Within the lumen of the caeca are spiral folds that produce a sacculated appearance.

FIGURE 14

Dorsoventral view of the thoraco-abdominal viscera of an ostrich (*Source*: Fowler, 1991)

(Lt = left, Rt = right)



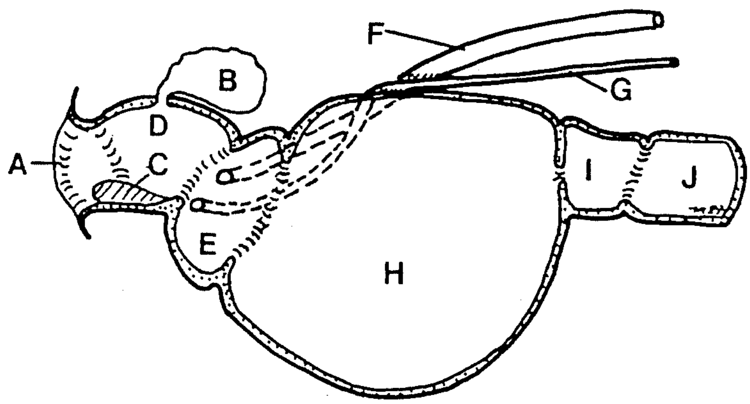
H - Heart
Pr - Proventriculus
D - Duodenum
Cl - Cloaca
L - Liver
C - Cecae
J - Jejunum
V - Ventriculus
I - Ileum
R - Rectum

The rectum in the ostrich is voluminous and occupies the caudal right abdomen. Such a long and large rectum is necessary for digestion of bulky food items and fluid absorption. The rectum enters the cloaca via a rectal pouch and then enters the coprodeum (Figure 15). The rectal pouch is separated from the coprodeum by a rectocoprodeal fold. The coprodeum is a large dilated sac covered by a dark tough membrane similar to koilin. The coprodeum and urodeum are partially separated by a copro-urodeal fold. The urodeum is short but within it are orifices for the ureters, the oviduct of the female and the vas deferens of the male. A uroproctodeal fold partially separates the urodeum from the proctodeum through which all excretions pass via the vent to the exterior. The brusa of fabricius is on the dorsum of the proctodeum.

FIGURE 15

Right lateral view of the cloaca of an ostrich (*Source*: Fowler, 1991)

A. vent; B. brusa of fabricius; C. genital eminence; D. proctodeum; E. urodeum; F.ureter; G. genital duct; H. coprodeum; I. rectal pouch; J. rectum



The liver is cranial to the ventriculus and caudal to the diaphragm (the transverse membrane). The gall bladder is absent in the ostrich.

Figures 16 and 17 show diagrammatic representation of the relative position of the different parts of the gastrointestinal tract in the adult ostrich.

FIGURE 16
Left lateral view of the thoraco-abdominal viscera of an ostrich (*Source*: Fowler, 1991)

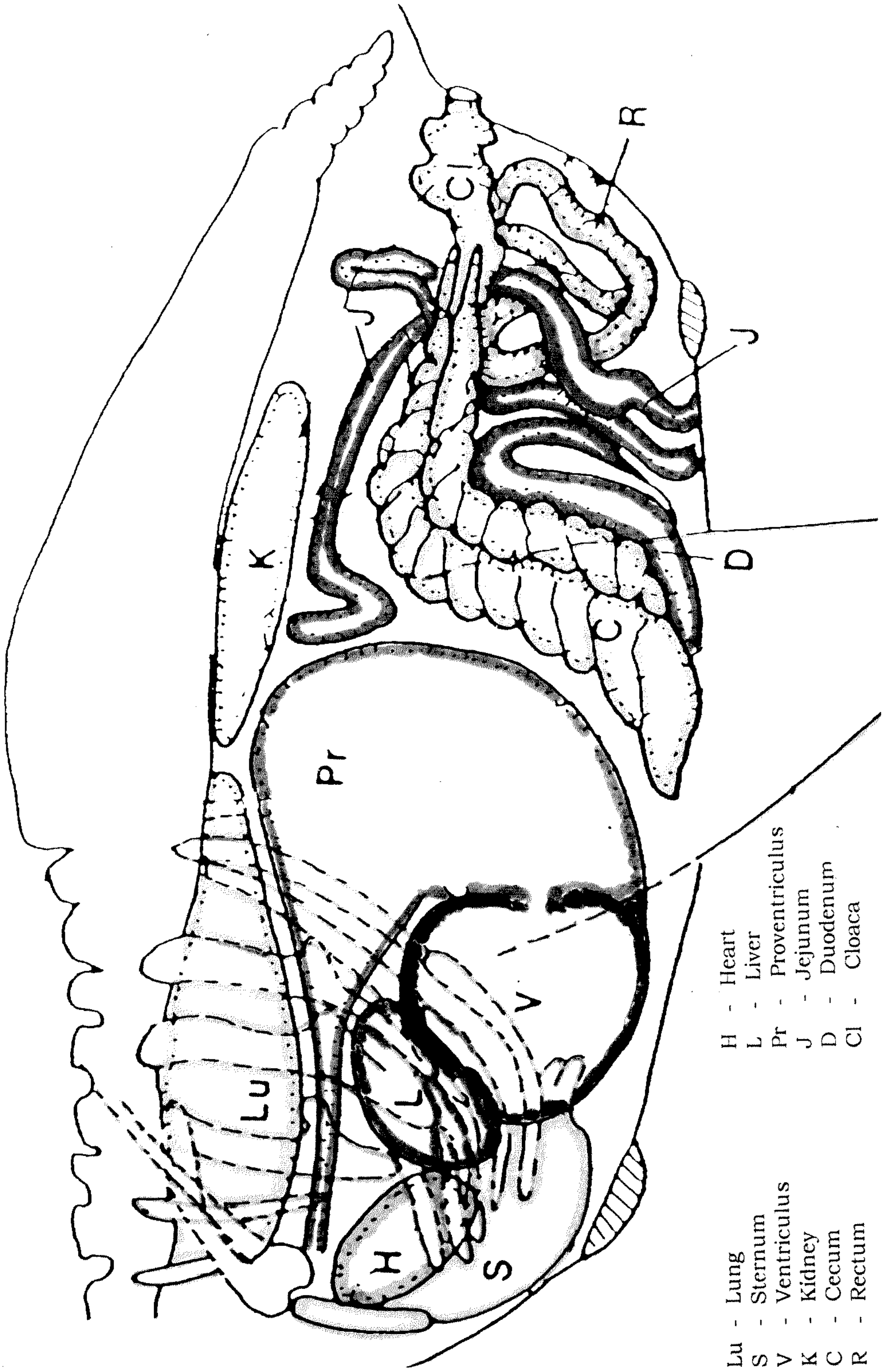
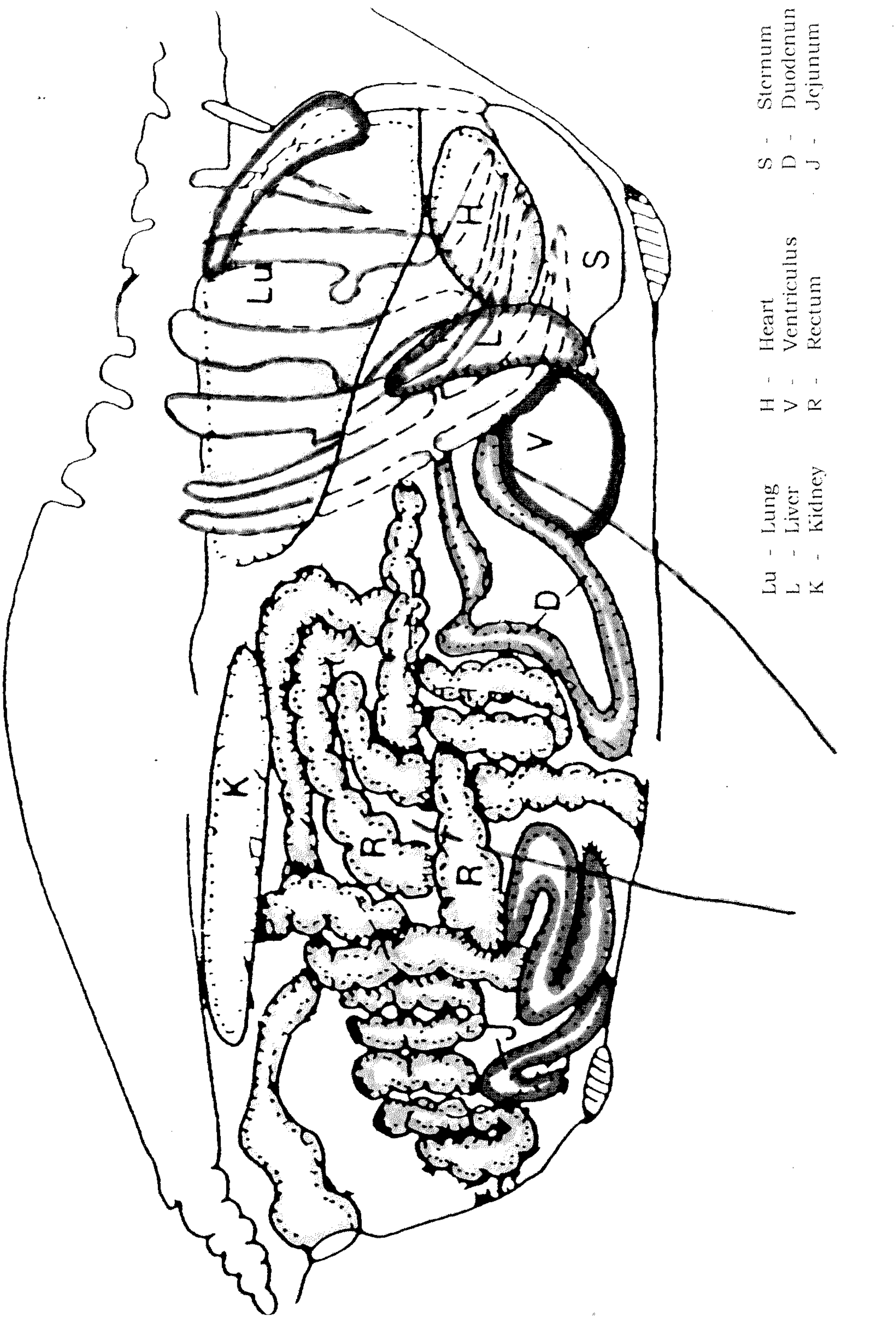


FIGURE 17
Right lateral view of the thoraco-abdominal viscera of an ostrich (*Source*: Fowler, 1991)



RESPIRATORY SYSTEM

The respiratory system starts at the nostrils which lead, via the nasal cavities, to the larynx. The larynx extends into the trachea which divides, at the base of the neck, into two bronchi. The larynx of all ratites is well developed. There are, however, no vocal folds and no epiglottal cartilage, but the arytenoid, cricoid and thyroid cartilages can be identified. Ostriches are easily intubated because the glottis is large and readily accessible when the mouth is held open and the tongue pulled forward (an 18-mm [ID] endotracheal tube is suitable for intubating an adult ostrich).

The trachea has complete flexible cartilaginous tracheal rings that are flattened dorsoventrally to produce a compressed ring (2.5 x 4 cm) or an ellipse (2.5 x 3 cm) in the ostrich. Ostriches are relatively avocal; thus the syrinx is poorly developed. The cartilaginous tracheal rings continue on to the bronchi but are incomplete medially. A tympanic membrane similar to that seen in the peafowl (*Pavo cristatus*) is present.

The lungs are imbedded around bony structures of the dorsal thorax. The general anatomy of the air sacs of ostriches is similar to that of flight birds. The only pneumatized bone, however, is the femur. Although the ostrich lung is relatively small compared to that of mammals, it is a more efficient gas exchanger. The meshwork of blood capillaries in the lung is less than one-third the size of the smallest mammalian alveolus. Air and blood flow take place at right angles to one another in this latticework. The net resultant is a surface for gas exchange approximately ten times more extensive than that of mammals.

The respiratory rate of an adult ostrich in a mild ambient temperature varies from 6 to 12 breaths/min. If the bird is subjected to thermal stress, panting may increase to the rate of 40-60 breaths/min. An ostrich can maintain a body temperature of 38-40°C (mean 39.1°C) even when the ambient temperature reaches 56°C. Body temperature is maintained by evaporative cooling from the trachea, air sacs and the gular area of the pharynx. It should be noted here that ostriches do not become alkalotic when panting because the air is carried through the primary bronchi and air sacs bypassing the lungs.

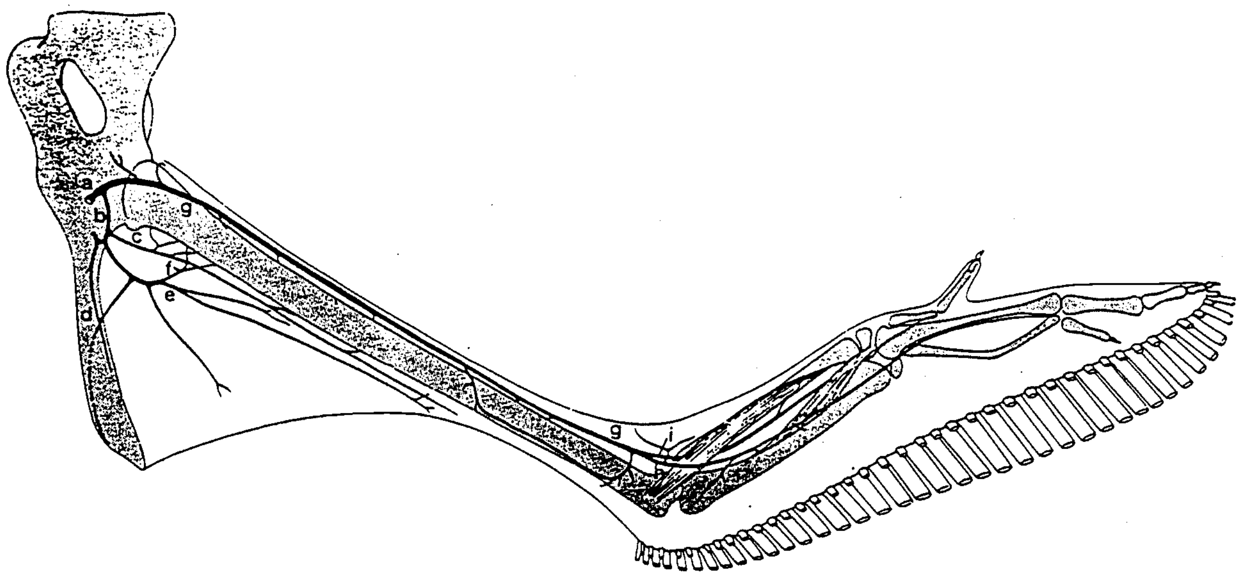
CIRCULATORY SYSTEM

The heart is four-chambered, similar to that of other birds and mammals. As stated earlier, veterinarians are increasingly called upon to obtain blood samples or to give intravenous injection in ostriches. More emphasis is placed in this section, therefore, on describing the location of superficial veins suitable for such tasks.

The jugular vein is a primary site. As in other avian species, the right jugular vein in the ostrich is much larger than the left. The size and location of the left jugular vein is variable; in some ostriches it joins the right jugular, in others it empties into the cranial venacava. The common carotid artery of ostriches arises from the aortic arch and courses up the neck along the ventral border of the vertebrae and deep to the cervical muscle mass.

FIGURE 18
Major arteries of the ostrich's wing (ventral view) (*Source*: Bezuidenhout and Coetzer, 1986)

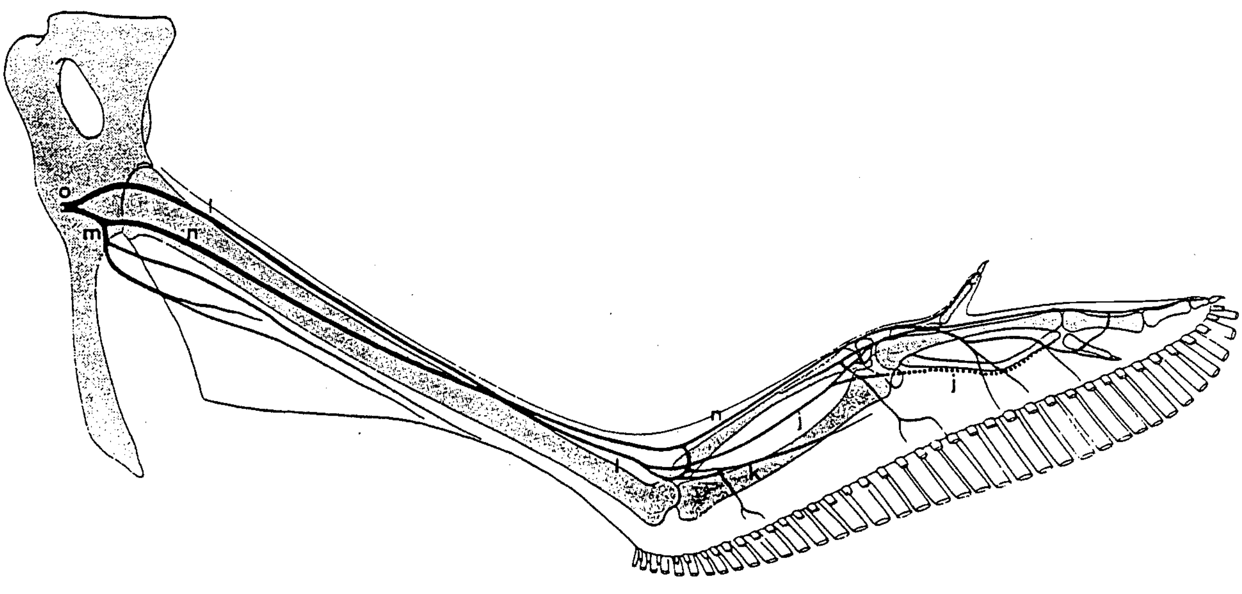
a. *A. axillaris*; b. *A. brachialis profunda*; c. *A. collateralis ulnaris*; d. *A. subscapularis*; e. *A. collateralis radialis*; f. *A. circumflexa humeri dorsalis*; g. *A. brachialis*; h. *A. ulnaris*; i. *A. radialis*



Other sites for blood collection are the wing veins. It should be noted here that although the venous drainage of the ostrich wing parallels the arterial supply, they both differ substantially from those of other birds (Figure 18). In the domestic fowl, for example, the deep brachial artery (or its branches) and the radial and ulnar collateral arteries anastomose at or just distally to the elbow with the brachial artery (or its branches) and the radial and ulnar arteries. In the ostrich, no anastomoses occur between branches of the deep brachial and the brachial arteries. Because of its size and location, the basilic vein (see Figure 19) appears to be the only vein in the wing of the ostrich suitable for vein puncture. All other veins are either too deeply situated or too small. The best site for arteriopuncture is the brachial artery (Figure 18), where it passes over the ventral aspect of the head of the humerus. In this position there are no structures that might be damaged.

FIGURE 19
Major veins of the ostrich's wing (ventral view) (*Source*: Bezuidenhout and Coetzer, 1986)

j. *V. radialis*; k. *V. ulnaris*; l. *V. brachialis*; m. *V. brachialis profunda*; n. *V. basilica*; o. *V. axillaris*



Haematological and chemical blood parameters of clinically normal ostriches can be found in Appendix 1.

Ostriches have a renal portal system (RPS) similar to that of other birds and reptiles. Although the precise physiological function of the RPS is unknown, the flow of venous blood through the kidneys is under autonomic nerve control. Because of the renal portal system, nephrotoxic drugs, such as aminoglycoside antibiotics, may reach the kidneys in high concentration if administered in the muscles of the leg. Furthermore, drugs that are excreted via the kidney tubules, such as ketamine HCl, may be excreted before reaching the general circulation, precluding the desired effect.

NERVOUS SYSTEM

The ostrich nervous system has no unique characteristics; however, ostriches are not noted for their intelligence. Although the birds can lie in sternal recumbency for days, lateral recumbency for one hour may result in peroneal nerve paralysis. Heavy muscling over the proximal tibio-tarsal bone produces a significant bulge, and the weight of the bird pressing on this bulge may cause direct pressure on the peroneal nerve or produce ischemic edema. Adequate padding, perhaps in the form of an air mattress or foam pad, should be used when adult birds require general anaesthesia.

URINARY SYSTEM

The kidneys and ureters of ostriches are similar to those of other birds. The renal portal system has been described earlier under the circulatory system. The kidneys of the ostrich are chocolate brown in colour, granular in texture and lie in a depression in the pelvic cavity of the dorsal wall. Urine is secreted continuously and passes down the ureters to the urodeum. Although there is no bladder, a dilated pouch of the ureter stores the urine until discharged.

Ostriches drink relatively large volumes of water daily and also excrete relatively large quantities of highly diluted urine. When drinking-water is unavailable or withdrawn, the urine becomes highly concentrated with urates, and after two days small amounts of very viscous urine are secreted. Within one hour of drinking-water being provided, the renal function returns to normal. It seems that ostriches normally drink relatively large quantities of water and rely on renal conservation of water when drinking-water is scarce.

REPRODUCTIVE SYSTEM

In the female ostrich, as in all other birds, only the left ovary and oviduct usually develop. Kiwis are the only exception since they are the only birds in which both left and right ovaries consistently develop and become fully functional. In the mature ostrich, a flattened cluster of ova is present, each ranging in size from 1-8 cm in diameter. The fan-shaped infundibulum (funnel) is the first part of the thin-walled oviduct, where fertilization occurs. Following the funnel is the magnum where albumen is added and then the isthmus where the two shell membranes are coated over the albumen. The total length of these three parts is approximately 118 cm long and 3 cm in diameter. The uterus is a thick-walled expanded segment of the oviduct. It is in the uterus (also called the shell gland) that the hard shell is formed from secretions of the calcareous glands. The shell cuticle of the ostrich egg is an enamel-like layer which is deposited over the hard shell, giving the egg its smooth surface. The oviduct continues on to the urodeum of the cloaca.

FIGURE 20
The phallus (penis) of an adult ostrich male

The paired testes of the male overlay the upper lobes of the kidneys. They are bright yellow in immature birds and slightly tanned (greyish-brown) in mature males. Approximately 1 x 1 x 4 cm each in size, they enlarge during the breeding season to over 5 x 6 x 12 cm (115 g in weight). Once the male begins to incubate, they shrink considerably to enlarge again in the next breeding season. All ratites, including the ostrich, have an intromittent organ commonly called a phallus (Figure 20). Although the ostrich phallus is analogous to the mammalian penis, it is not homologous. There is no urethra in the ostrich phallus, and it does not have a urinary function as does the mammalian penis. Ratites have two different types of phalluses. Ostriches (and kiwis) have an intromittent phallus with no internal cavity. When relaxed it is folded on the ventrum of the proctodeum of the cloaca. On the dorsum of the phallus is a phallic sulcus responsible for directing the semen into the cloaca of the female.

Reproductive organs of adult ostriches

The phallus (penis) of the adult male is bright red and irregularly round in cross-section and lies folded in a wide pocket on the floor of the proctodeum when flaccid (Figure 21-I). The phallus is approximately 20 cm long and is so bulky that it may occupy most of the proctodeum and protrude from the vent to allow defecation and urination. The phallus when erect (about 40 cm long) projects from the cloaca in a ventrocranial curve, with the phallic sulcus on the dorsum at the base (see Figure 21-II). Because of the asymmetry of the fibrolymphatic bodies, the erect phallus tends to deviate to the left. The exact mechanism that stimulates erection is still unknown.

The female ostrich has a diminutive phallus (3 cm long), which projects from a genital mound or eminence on the floor of the proctodeum. There may be a minimal groove on the dorsal surface. The female phallus is flattened in cross-section.

Reproductive organs of chicks and juvenile ostriches

Juvenile ostriches may be sexed by everting the proctodeum through the vent. Practice is required to identify the structures on the ventrum of the proctodeum consistently. A small bird may be held on its back on the lap of a seated person with the tail directed away from the holder's body. The person examining the bird should place the middle finger of each hand below the point of flexion of the tail. The thumbs may then bend the tail downwards, providing maximum exposure of the vent. The index fingers may be used to evert the proctodeum by exerting pressure cranial to the cloaca and squeezing caudally. Faeces and urates may be expelled in the process. Older juveniles may be held upright by supporting the bird under the sternum.

Alternate methods of sexing chicks and young juveniles include insertion of a moistened cotton-tipped applicator stick or a plastic rod through the vent and lifting the phallus out. In ostrich chicks (less than or equal to 10 kg in weight), a lubricated finger may be inserted through the vent to retrieve the phallus.

The phallus of the female is flattened, with only a trace of a groove on the dorsal surface (Figure 22-II), whereas the male phallus is irregularly rounded in cross-section with a prominent groove on the dorsal surface (Figure 22-I). The phallus of a seven-month 53-kg juvenile male is typically 1.0 x 1.5 x 3.0 cm, and the crura of the phallic bodies are prominent on the floor of the proctodeum.

FIGURE 21
Left lateral view of the cloaca and phallus of an adult male ostrich (*Source*: Fowler, 1991)

A. vas deferens; B. urodeum; C. proctodeum; D. uncovered crypt on the floor of the proctodeum; E. retracted phallus; F. vent; G. dorsal sulcus; H. erect phallus

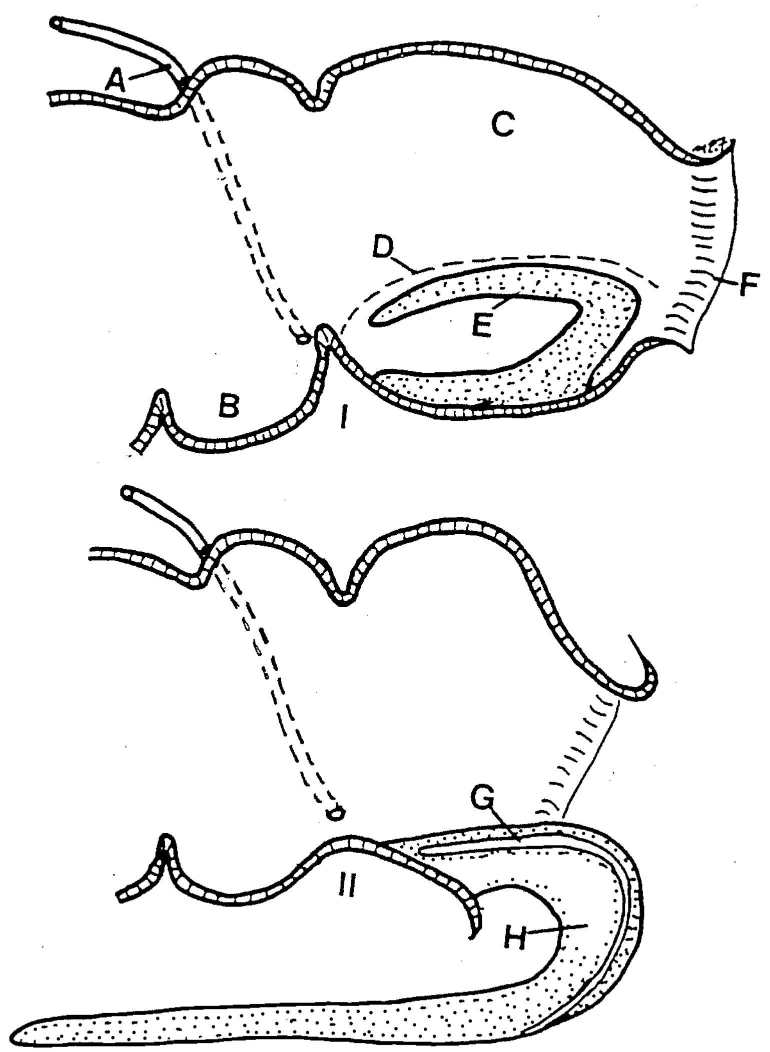
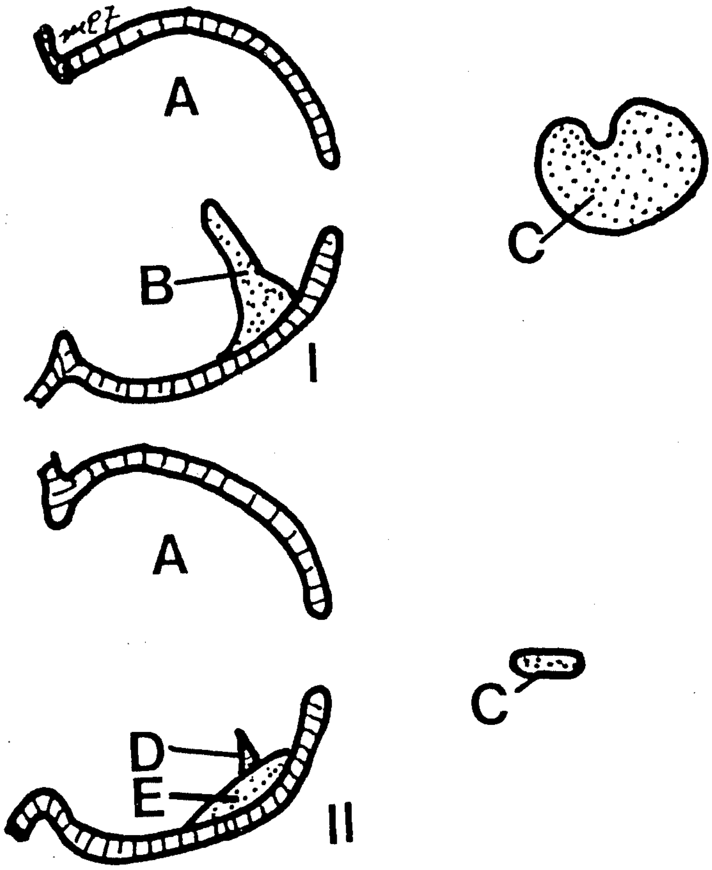


FIGURE 22

Left lateral view of the cloaca of chicks and juvenile ostriches (*Source*: Fowler, 1991)

I. male ostrich; II. female ostrich

A. proctodeum; B. male phallus; C. cross-sectional view of the phallus; D. female phallus; E. genital eminence



ORGANS OF SPECIAL SENSE

With the largest vertebrate eye relative to body size, ostriches have excellent vision. Their sense of hearing is also acute. The external ear orifice is easily located caudal to the eye. The ear canal should be checked for ectoparasites (see Chapter 9).

Chapter 3
Farming systems

In the wild, ostriches are well adapted to the environment in which they have evolved. The process of natural selection favours those that are best adapted to their eco-niches. When exposed to environmental changes, the birds first try to modify adverse conditions or they leave to look for more suitable places for their needs. Farming a particular species profoundly alters the natural selection process by providing the birds (or animals) with food and shelter and by partially or totally restricting their freedom of movement. Depending on the new environment in which they are kept, farmed ostriches can, therefore, be very dependent on their housing system.

There are basically three types of farming system available for ostrich production: extensive, semi-intensive and intensive. The choice as to which system to use is essentially governed by availability and price of land, scale of production and labour and feed costs. In the first two systems, there is an additional choice as to whether to use natural or artificial incubation. With intensive systems, artificial incubation and hatching of eggs are always employed (see Figure 23).

FIGURE 23
Types of ostrich farming systems

Extensive system	with natural incubation
	with artificial incubation
Semi-intensive system	with natural incubation
	with artificial incubation
Intensive system	with artificial incubation

EXTENSIVE FARMING SYSTEM

This type of system requires a large area of land in excess of 40 ha (100 acres). Apart from the cost of the birds (which is common to all systems), land is the major capital requirement. The birds are kept and raised as near as possible to their natural habitat, with minimum interference.

The main advantage of the extensive farming system is the greatly reduced cost of keeping adult birds in large numbers. Moreover, incubation costs are not incurred if the birds are allowed to hatch their eggs. Thus, production costs are extremely low.

However, the disadvantages can easily outweigh the advantages of this system. Monitoring and identification of the birds and collection of eggs (for artificial incubation) often prove to be a problem. No control over breeding conditions can be exercised. Eggs collected for artificial incubation may be transported over rugged land and this may often cause damage to the delicate internal structure of the eggs. Mortality and loss of birds are often high, particularly among chicks, because of the high degree of predation. The physical capture of birds is complex and expensive, and birds are generally difficult to handle through lack of human contact.

SEMI-INTENSIVE FARMING SYSTEM

The area required for this type of system varies from 20 to 60 ha (50-150 acres). The birds are kept in relatively small paddocks or territories of approximately 8 to 20 ha (20-50 acres). They are able to roam freely to a certain extent, thus obtaining some of their nutritional requirements from the pasture. Supplement feeding (amounting to 40-60 percent of total feeding) is required to ensure that all the birds' nutritional requirements are met. Feeding sites should be located near the perimeter fencing, to increase accessibility and reduce the degree of disturbance caused by frequent entry into the paddocks.

There are a number of advantages in using the semi-intensive farming system. These include the relative ease in identifying good producing birds and collecting and transporting the eggs (for artificial incubation); savings in feed and fencing costs; and the freedom provided to the birds to choose their mates and hence increase compatibility. However, the physical capture and handling of the birds remain a problem, as is the extreme difficulty in maintaining any accurate breeding records.

INTENSIVE FARMING SYSTEM

The area required for the intensive farming system is normally less than 20 ha (50 acres), divided into small paddocks of 1-2 ha (3-5 acres) each. This system is popular as an ostrich farming system because of the small land area involved. However, there are two clear disadvantages associated with the intensive system. First, higher feed costs, as birds need to be provided with all their feed and, second, the higher cost of fencing. Capital investment is higher per unit of land area. Nevertheless, the advantages of using the intensive farming system are numerous and by far outweigh the disadvantages. The major advantage of intensification is that there is full control over breeding, through keeping accurate and precise records of the number of eggs produced by each hen and their fertility and hatchability. These records are invaluable for assessing the eventual value of the stock, whether for resale, retention for breeding, or slaughter. Selective breeding of quality birds can be performed. Furthermore, accurate feed consumption records can be maintained, which enable operators to assess the feed conversion efficiency of the stock, whether in terms of the efficiency of body growth or of egg production. Examination and handling of birds do not present problems under the intensive farming system.

OSTRICH FACILITIES

This section deals with the design of facilities for commercial ostrich operations. Depending on the degree of specialization involved, there are basically four types of facilities needed. These are breeding paddocks, a hatchery, brooding/rearing facilities and growing facilities. Ostrich operations may specialize in one or all of the above aspects of production. The ostrich abattoir is normally an independent operation. Details involved in the construction of breeding paddocks are described and discussed in the next chapter.

General considerations

Before starting to construct ostrich facilities, a number of points need to be considered and addressed.

Farm location. Distance from traffic and industrial areas is an important factor to consider. Disturbances caused by heavy traffic, airports, factories, trains, etc. can affect the birds' performance, particularly during breeding. Overhead high-voltage cables can emit electromagnetic radiation.

Land topography. Hilly, mountainous, sloping, rocky or steep ground is not suitable since ostriches prefer flat open terrain. Excessive tree covering can be a problem and also attracts wild birds. Sandy soil is best for efficient water drainage. Ground should be cleared of nails, screws, wires, holes, etc.

Availability of water and electricity supply. It is far easier and cheaper to have mains electricity on an ostrich farm than to run generators. A stand-by generator, however, is a must for the hatchery. A clean underground water source or mains water supply is vital. High soluble salt content in the water can affect shell quality and reduce hatchability.

Positioning of buildings. In buildings where natural ventilation is to be used, two factors need to be considered. First, the buildings should be at right angles to the direction of the seasonal wind and, second, the width of the building should not exceed 15 m. Where artificial ventilation is to be used, buildings should lie parallel with the direction of the seasonal wind in order to minimize wind interference with the efficiency of the fans. Furthermore, the location of farm buildings should facilitate daily operations. Breeders' quarters should be away from the brooding/rearing facilities. If land availability is a problem, breeders' facilities should be located downwind, to minimize transfer of disease from breeders to rearing facilities.

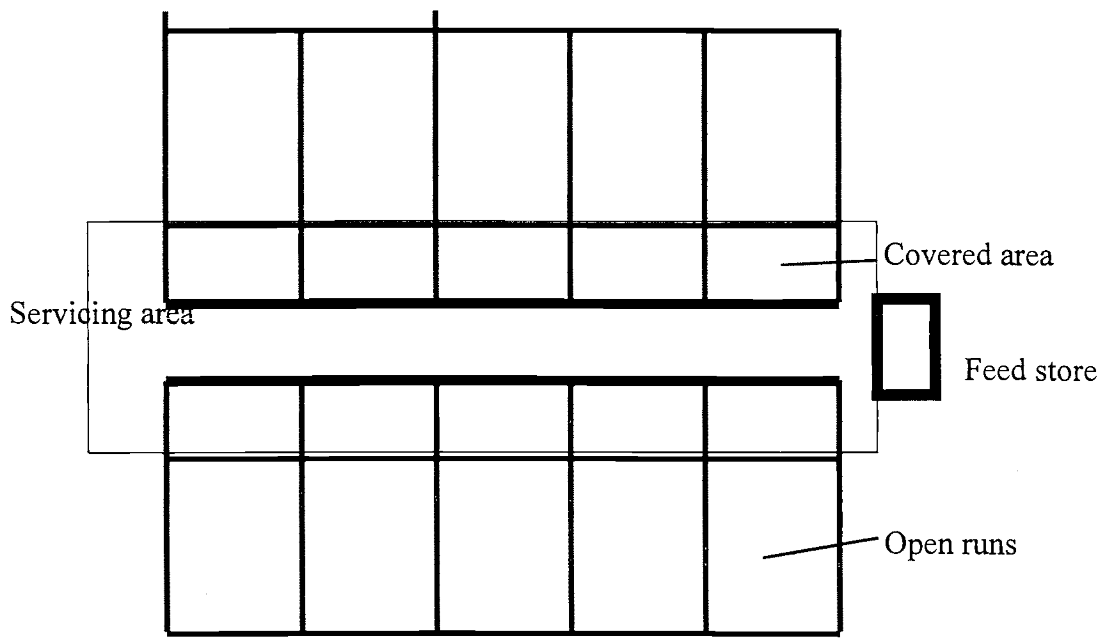
Design of facilities. Facilities should be designed to allow ample room for manoeuvring vehicles and trailers. Loading (and unloading) bays should also be considered. If possible, the design should allow room for future expansion. All pens or enclosures should be built so that water drains away. Interior surfaces and fences should be free from any sharp objects. Barbed wire should never be used on an ostrich farm since it can be one of the main causes of injury.

Design of ostrich facilities

There are hundreds of possible designs to choose from. The most widely used is the simple rectangular design with a long service area (corridor) running down the centre of the pens (Figure 24). Each pen has its own run extending outwards on both sides of the central service corridor. This is, appropriately, called the "double-sided comb design". Attached to the service corridor is a feed storage area. The length of each run is no less than three times the length of the covered area, to ensure that the birds have plenty of

FIGURE 24

Simplified drawing of the double-sided comb design of ostrich farms

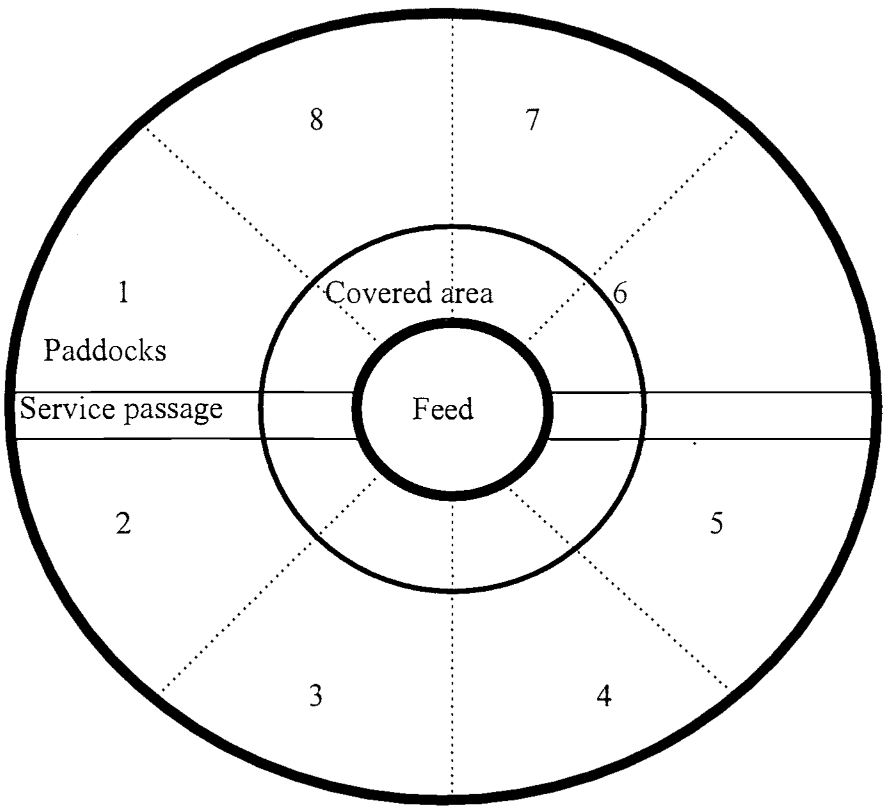


exercise. This design is particularly suitable for birds from the age of three to 16 months (depending on the area of each run) .

Another design that is being adopted by large producers is based on the "central composite design". Pens and their accompanying runs fan out from a central point. The inner circle is used as a service area with easy access to all pens (see Figure 25).

FIGURE 25

Simplified drawing of the full central composite design of ostrich farms



Variations on the full composite design (half or three-quarters) can be used, depending on available land area. The shape of the service area can also be changed to a hexagon (for a six-paddock design) or octagon (for an eight-paddock design). This design is used for breeding birds as well as for yearlings.

Figures 26-28 show examples of different designs in various parts of the world.

FIGURE 26
Examples of ostrich facilities

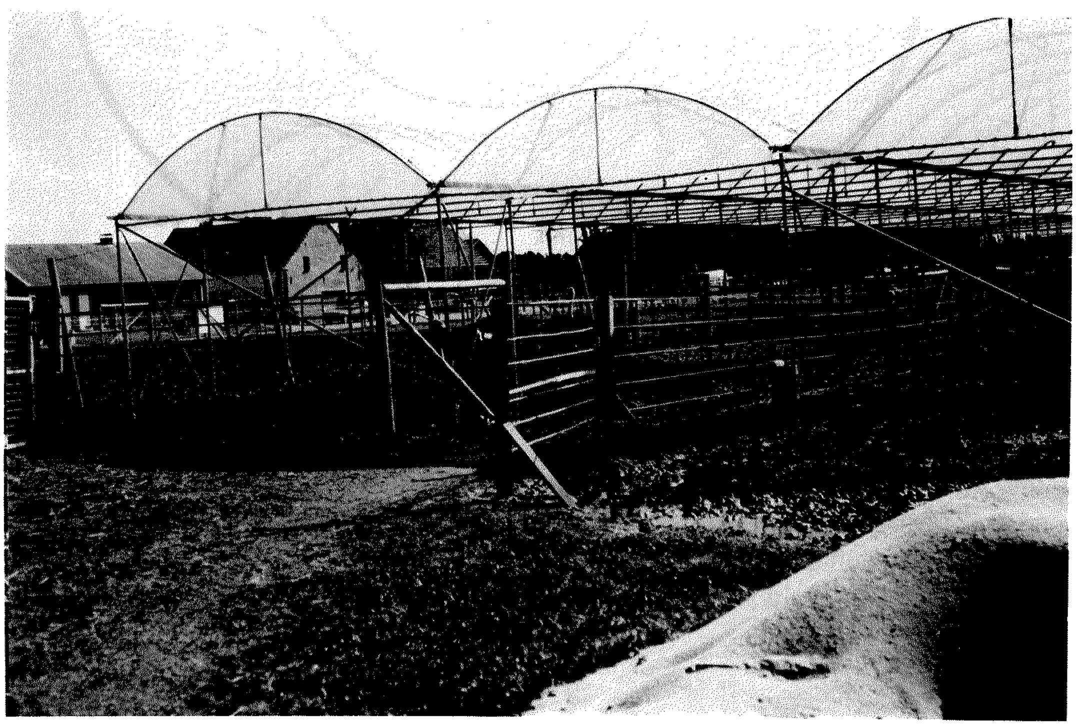
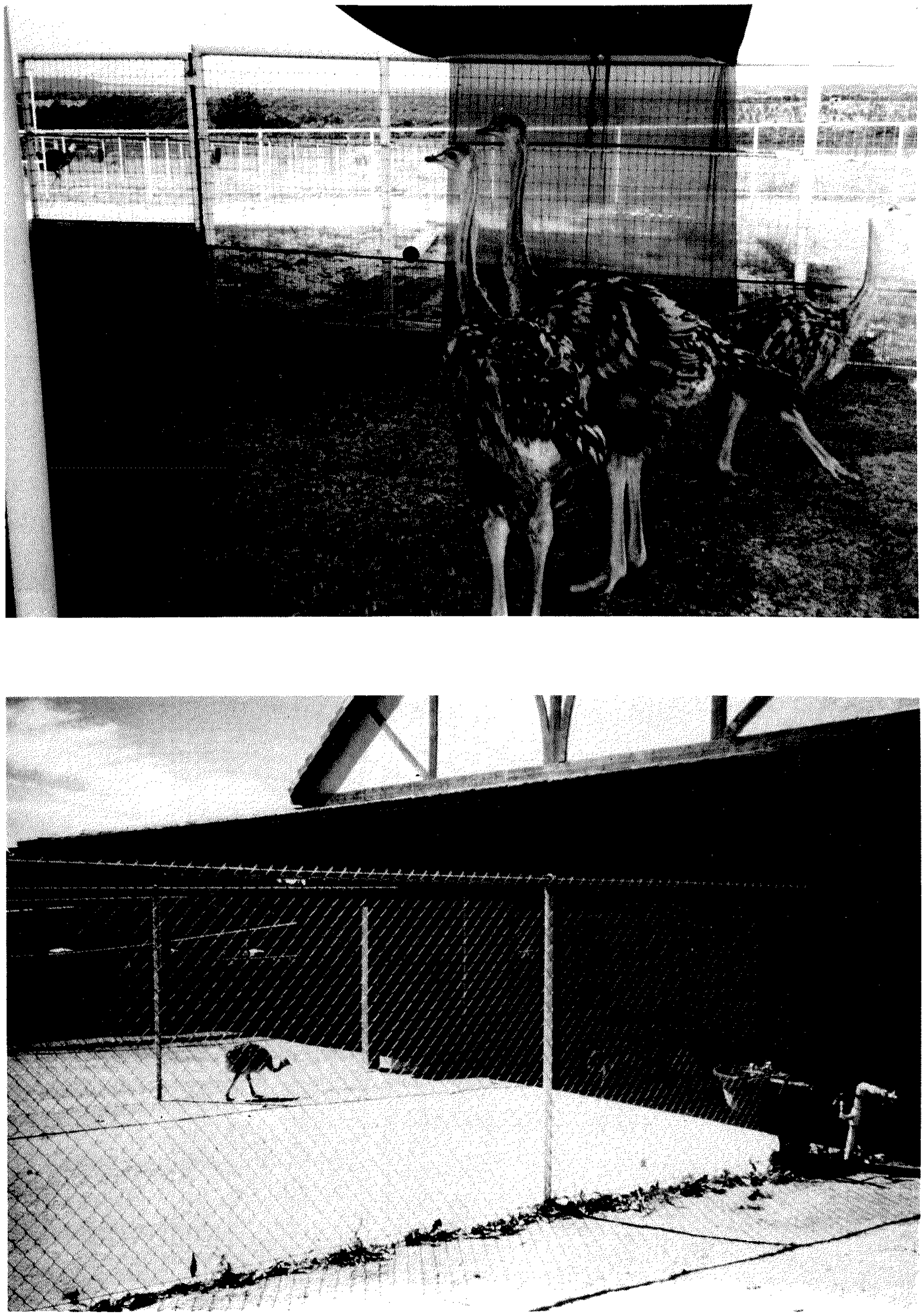


FIGURE 27
Examples of ostrich facilities

FIGURE 28
Examples of ostrich facilities



Bedding materials

Various bedding materials are or have been used in ostrich operations throughout the world; some are elaborate and some are quite simple. A bare concrete floor is not practical for chicks or young birds since it is hard, cold, retains moisture and germs, and is abrasive on chicks' feet. If rough, it is difficult to clean and if smooth, it becomes too slippery in the presence of any small amount of moisture or dirt. Similarly, a dirt (soil) floor is not practical since it is virtually impossible to clean, retains odours and can easily lead to ammonia buildup. Dirt floors also become dangerously slippery when the soil is mixed with faeces and urine.

Nevertheless, there are many types of materials that can be used on concrete floors to provide bedding for ostrich chicks. The simplest are enamel paints or sealers. These solve the problems of moisture retention and cleaning, but they can only be applied in very thin coats and will crack with substrate movement. Furthermore, they can easily become slippery when slightly damp or wet. Urethane paint mixed with sand grit helps to provide an adequate slip-resistant surface but the sandpaper-like surface is too abrasive for the chicks' feet. A liquid rubber base with unlimited thickness of application solves many of the above problems but is expensive.

There are different types of "removable" bedding materials such as sand, sawdust (wood shavings), chopped straw, small gravel (pea gravel), etc. that have varying degrees of success and efficiency. Dust-extracted wood shavings are cheap, readily available and provide warmth for the chicks, in addition to having a high moisture-holding capacity. However, very young chicks may consume large quantities of the shavings and become impacted. Care should be taken to make sure that the chicks know where food is before they are moved on to wood shavings as bedding (at about four weeks of age).

Removable floor materials such as artificial turf, carpets and rubber mats have also been used. High quality artificial turf and grass-like carpets are expensive and tediously difficult to clean. Moreover, chicks are often able to peck fibres from the surface, which accumulate inside the birds and cause impaction and death. Rubber mats are reasonably priced and appear to provide good flooring with ease of cleaning. However, the surface of the rubber sheets should not be too smooth.

Different types of raised floor can be used. These include perforated plastic or rubber lock-together tiles of various sizes, wire and nylon mesh. The big advantage of using raised floors is that urine can pass through and so the birds remain dry. Moreover, the need for frequent cleaning is reduced. The problem lies with the faeces. If the individual perforation (the squares or holes) is large enough to allow the faeces to pass through, the chicks may get their toes caught, causing serious injuries in many cases. Yet if the squares are kept small to prevent the chicks' toes from becoming trapped, then the faeces cannot drop through. Furthermore, there is an age limit for birds kept on raised floors, because of their increasing weight on the floor.

One of the latest types of flooring for ostrich chicks is heated floor pads. These combine rubber sheets (or other types of matting) and a heating element to keep chicks dry and warm. Needless to say, the cost of these systems is high, but so is the survival rate of the chicks. There is also a significant saving in traditional heating sources. A combination of different types of flooring and bedding materials has also been used. For example, the use of rubber mats for the first four weeks of age followed by treated wood shavings is relatively inexpensive and gives satisfactory results.

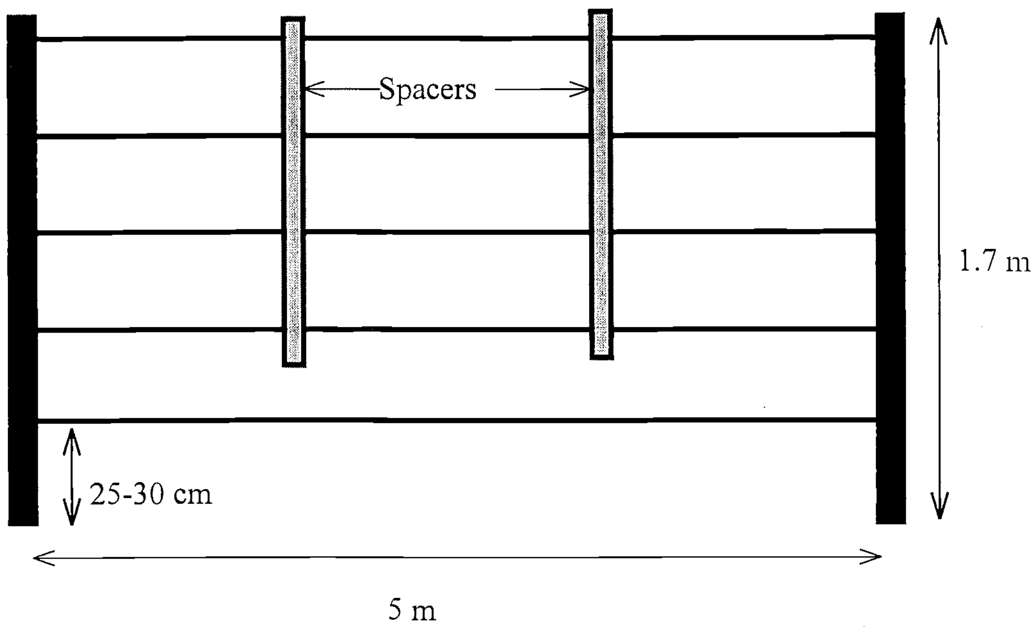
Fencing

Fencing should be at least 150 cm high for birds up to 12 months and 165-170 cm for older birds. It must be:

- easily seen by the birds;
- strong enough to withstand birds colliding with it;
- resilient enough not to injure the birds;
- free from projections and sharp parts;
- of a type that a bird's head or legs cannot become trapped.

FIGURE 29

Ostrich fencing of five wire strands and two spacers (suitable for adult birds)



The simplest form of fencing is five strands of high tensile galvanized smooth steel wire (3.1 mm gauge), mounted or suspended on round 15 cm diameter posts, 5 m apart. Between the posts, at least two "droppers" should be placed to act as visible upright barriers for the ostriches (Figure 29). Corner posts should be round and 20 cm in diameter and there should be at least one midway post for extra strength. The first strand should be

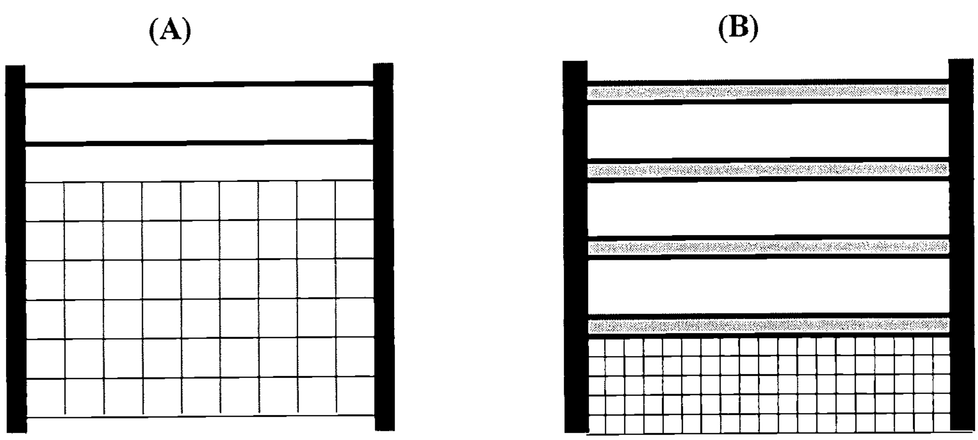
25-30 cm above ground level, to enable the handler to make a quick escape should the situation arise.

There are many variations on standard wire-strand fencing. A combination of woven wire (5 x 10 cm) similar to that used for sheep fencing can be used together with two strands of wire on 15 cm posts, 9-12 m apart. Sheep netting is used for the first 150 cm above the ground, with two strands above (Figure 30-A). This is particularly suitable for young birds. Rails or coloured builders' tape can be fixed between the posts to act as a visible barrier for the birds. A combination of 15 cm round posts and 5 cm steel tubes can also be used as fencing (Figure 30-B).

FIGURE 30

Different types of fencing for young and adult ostriches

(A) Sheep netting and two strands of wire
(B) Rabbit mesh and 5-cm steel tubes



Electric fencing is not recommended, even though it is being used in some African countries and on some ranches in the United States. Ostriches do not learn quickly and repeatedly injure themselves.

Examples of different types of fencing are shown in Figures 31-33.

FIGURE 31
Examples of ostrich fencing

FIGURE 32
Examples of ostrich fencing

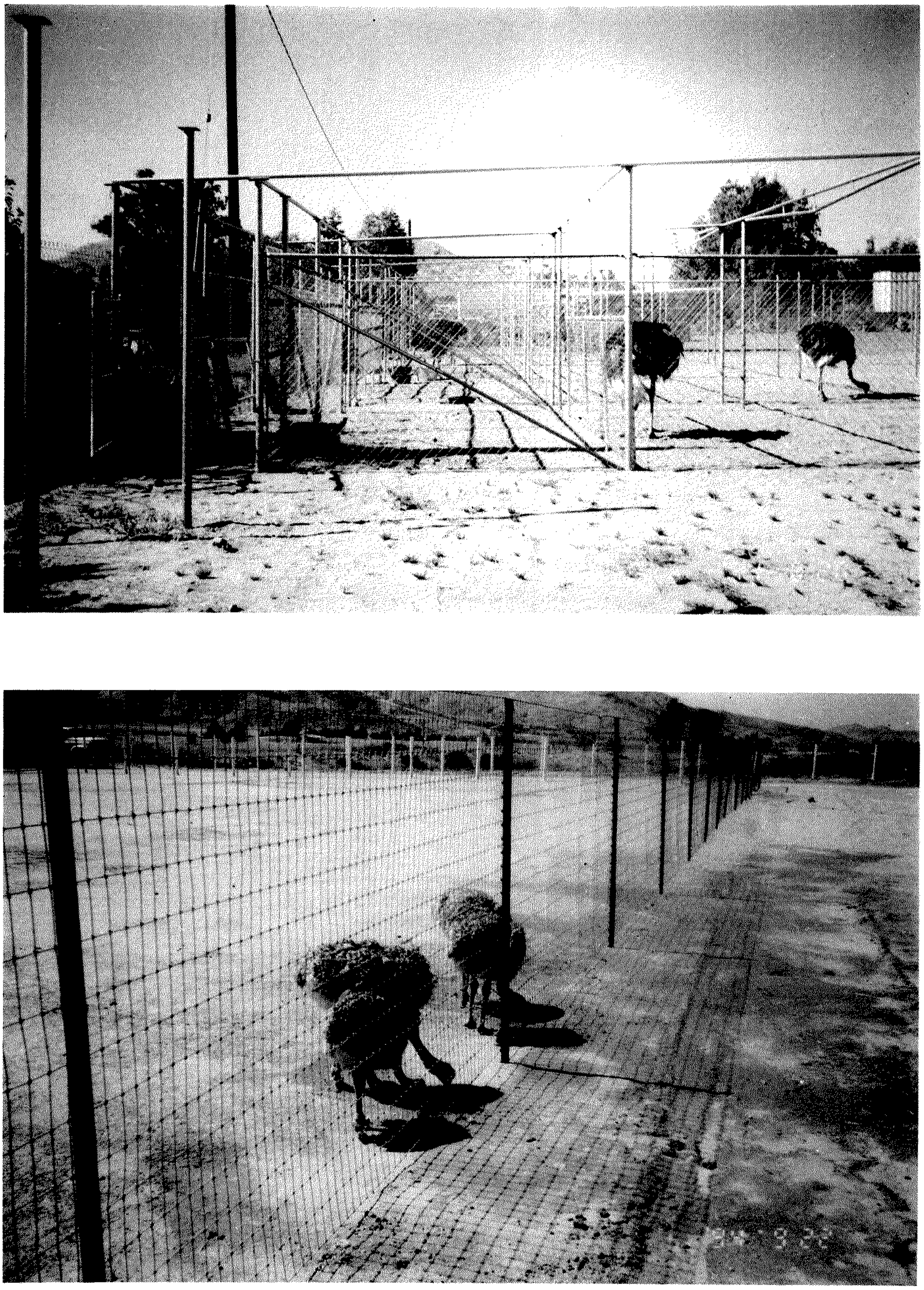
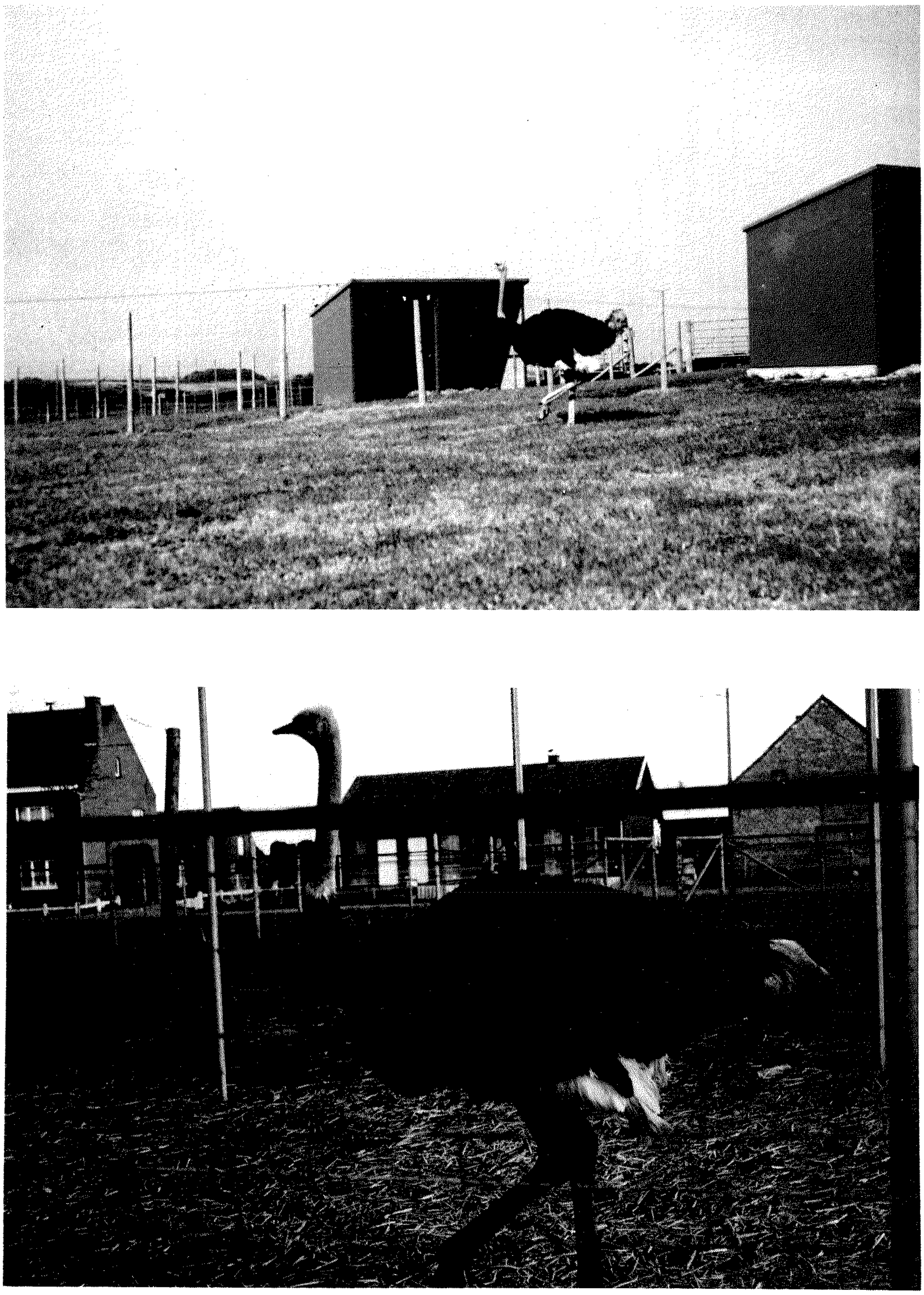


FIGURE 33
Examples of ostrich fencing



ENVIRONMENTAL INFLUENCES

Several animal activities are restricted in their occurrence to particular times of the year, which infers that the correct timing of these activities is necessary for the efficient organization, perhaps even the survival, of the species concerned. A feature common to many of the animal mechanisms is their concern with the regulation of annual reproductive cycles to ensure that offspring are produced when seasonal conditions are most favourable. In many cases this means that the chain of events starts long before the season itself and therefore a control system is required that anticipates favourable environmental circumstances. Weather and food supply cannot be predicted in detail, but the control system most favoured by natural selection is one that leads to the production of the young at a time of year when the probability of favourable conditions in the breeding season is greatest.

The most reliable natural indicators of the time of year are the height of the midday sun and the interval between sunrise and sunset. Both these features vary systematically with latitude and each seems, at first, rather difficult for an animal to measure with any degree of accuracy. There is, however, ample evidence that both are used - the sun's zenith in bird navigation and the day length (photoperiod) in various seasonal breeding mechanisms.

There are many examples of photoperiodic mechanisms throughout the plant and animal kingdoms. Seasonality, of course, is not the only aspect of the control exercised by light in the animal's environment. Short-term rhythms are important in themselves, e.g. in the control of egg laying rate in birds and the quality of light (its intensity and colour). The "absolute" length of day (or night) at any time, its length relative to the preceding or succeeding days, plus the changes in intensity of light marking the borders of day or night, are all factors which seem able to act as a time signal to some internal physiological mechanisms of the bird or mammal and thereby to assist its efficient functioning. Were human beings able to imitate these signals successfully they would be able to ensure the efficient physiological activity of ostriches at convenient times.

Photoperiod

When birds are exposed to artificial long days during the winter there is a prompt regeneration of the testes and ovaries, imitating the changes that occur naturally in the spring. Conversely, if birds are kept on short days throughout the spring and summer, little or no gonadal development occurs. As far as birds are concerned, therefore, long days are stimulatory and short days are inhibitory, while neutral days are those containing 12 hours of light (naturally occurring along the equator). It is important to note that the stimulus must be maintained if the response is to continue. This contrasts with some other photoperiodic mechanisms (e.g. flower initiation in many plants) where a few days of exposure to the appropriate day length are enough to trigger off the whole sequence of reproductive events.

Constant vs changing photoperiods

From the early 1930s to the late 1960s numerous studies were conducted to clarify whether the photoperiodic responses of birds (and mammals) should be described in terms of changes in day length or as responses to characteristic fixed levels of day length. The subject is rather like that misleading phenomenon, the iceberg - its volume is bigger than it first appears. Just as the visible mass of the iceberg is supported by the greater bulk below the surface of the water, so the patterns of light, which influence ostrich egg production, are themselves dependent on those that have gone before, i.e. during the rearing and growing periods.

The view that birds respond primarily to the change in photoperiod is now well accepted. Examples of the effect of hatching date on age of sexual maturity are abundant. The effect of photoperiod on birds can be classified in two different types or mechanisms depending on the age of the birds. During the brooding and rearing periods (the periods immediately after hatching), the amount of food consumed is directly related to the number of hours of light provided. The longer the light period, the greater the feed consumption. The effect of photoperiod here is merely one of allowing the birds access to feeders and drinkers. During the growing and laying periods, the effect of light is more complex. Light affects the nervous system, which in turn acts on the endocrine system, causing hormonal changes.

Influence of photoperiod on growth

For birds reared in natural daylight, there is ample evidence that the use of supplementary all-night lighting will increase early growth rate. Where natural daylight is excluded, maximum growth rate is obtained by using continuous or near-continuous light. For ostrich chicks, on the other hand, early fast growth rate is normally associated with a high incidence of leg abnormalities and therefore is not desirable. Hence the use of continuous or near-continuous lighting should be avoided once the chicks have learned where food is. Intermittent lighting has been widely used in the broiler industry but, apart from a slight economy of electricity, seems to have little to recommend it particularly as ostriches are not so fast in their response to lighting as chickens.

Influence of photoperiod on reproduction

Light affects reproduction in birds in two ways. First, there is a photoperiodic mechanism that, in nature, determines the onset and (in some cases) the termination of seasonal breeding at temperate latitudes. Second, there is what can be referred to as a "biological clock", which controls the timing of egg laying on any given day. In short, light affects the rate of sexual maturation (age at first breeding) and the rate of egg/sperm production (duration of the breeding season).

Ostriches take between two and two and a half years to reach maturity, which is much longer than other domesticated species. This is not the case, however, when compared with the wild or undomesticated ancestors of the present species, which normally reach maturity after one year of age. Wild quail, on the other hand, take over a year to mature, whereas domesticated quail mature after only six weeks. This reduction in age at maturity has been brought about by selective breeding and by the use of stimulatory light regimes during the growing period.

The most striking feature of the photoperiodic mechanism in birds (and particularly in fowl), and one which distinguishes it from most other photoperiodic phenomena, is that birds are more affected by changes in photoperiod than by the actual level of photoperiod at any one time. In the case of fowl, birds raised from hatching under a constant photoperiod reach maturity at about five months of age whether the photoperiod is short (e.g. six hours) or long (e.g. 22 hours). A botanist would thus classify fowl as "day-neutral", but they are not neutral in their response to day-length change. If the photoperiod is regularly increased during the growing period, sexual maturity is hastened; if the photoperiod is reduced, sexual maturity will be delayed.

Although there is limited research on the effect of light on ostriches, there is no reason to suggest that ostriches are any different. Undoubtedly, the photoperiod is the strongest stimulus to breeding. It is must be borne in mind, however, that wild ostriches are known to be opportunistic breeders. In addition to changes in day length (photostimulation), breeding can be triggered off, to a limited extent, by a number of other physical and psychological factors, including changes in ambient temperature, abundance of vegetation and availability of drinking-water. These factors act in combination with day length either singularly or in association with other related factors to control the onset and termination of breeding. A rainfall early in spring, for example, indicates the possible abundance of both water and lush green vegetation and would thus enhance the effect of photoperiod and further stimulate early breeding. Similarly, warm days help to extend the breeding season slightly.

Light intensity

The characteristic feature of a photoperiodic response is that it depends upon the duration of illumination and not upon the product of time and intensity. Thus a "long day" response which can proceed at a maximum rate in 15 hours of rather dim artificial lighting cannot be obtained by using, for example, nine hours of bright lighting, however much the light intensity may have been increased.

Compared with natural daylight, quite low intensities under experimental conditions are sufficient to operate the photoperiodic mechanism in plants and animals. If this is the case, why is natural daylight of such high intensity? Bearing in mind that the night is really "dark" for only a few days every month, the system has presumably been evolved so that the animal can make a distinction between bright moonlight and daylight.

Light intensity has a considerable effect on the behaviour of all birds including ostriches. If ostrich chicks are raised indoors, their activity will vary with light intensity. Outbreaks of cannibalism or feather pecking are more likely to occur under bright light conditions. These outbreaks can be cured by simply reducing the light intensity. One of the most dangerous situations arises when direct sunlight shines into the ostrich house or shed causing bright (and warm) spots. Control of ostrich activity is perhaps one of the most important advantages of windowless sheds or enclosures. It is important to point out, nevertheless, that cannibalism and feather pecking are a result of the complex interaction of many factors, not only light intensity, including type of feed, density of stocking and other features of management (see Chapter 9). In general, the brighter the light the greater the risk. Such a risk can usually be avoided by raising the chicks in houses that exclude daylight and in which artificial light is evenly distributed.

Colour of light

Birds in general seem to be more sensitive to the longer wavelengths within the visible spectrum (red and orange). The use of white light, however, is the most convenient and also avoids any possible reduction in luminous intensity.

Chapter 4
The breeding system

Ostriches are seasonal breeders, breeding only during particular seasons of the year. Their breeding or mating season lasts for six to eight months each year. However, the timing and duration of breeding vary with latitude and altitude. In the northern hemisphere, breeding commences in March and ends around August/September. In the southern hemisphere, it commences around July/August and finishes by the end of March.

SEXUAL CHARACTERISTICS

The wild ostrich is sexually mature at four to five years old, while the domesticated ostrich is mature at two to three years; the female is mature slightly earlier than the male. Some domestic ostriches may start their first breeding season (producing fertile eggs) as early as 18 months of age.

Male ostriches have a black and white plumage when mature. Females and immature birds are much duller, with a greyish-brown plumage. The young have a spiky, black-tipped puffy plumage until they are about four months of age.

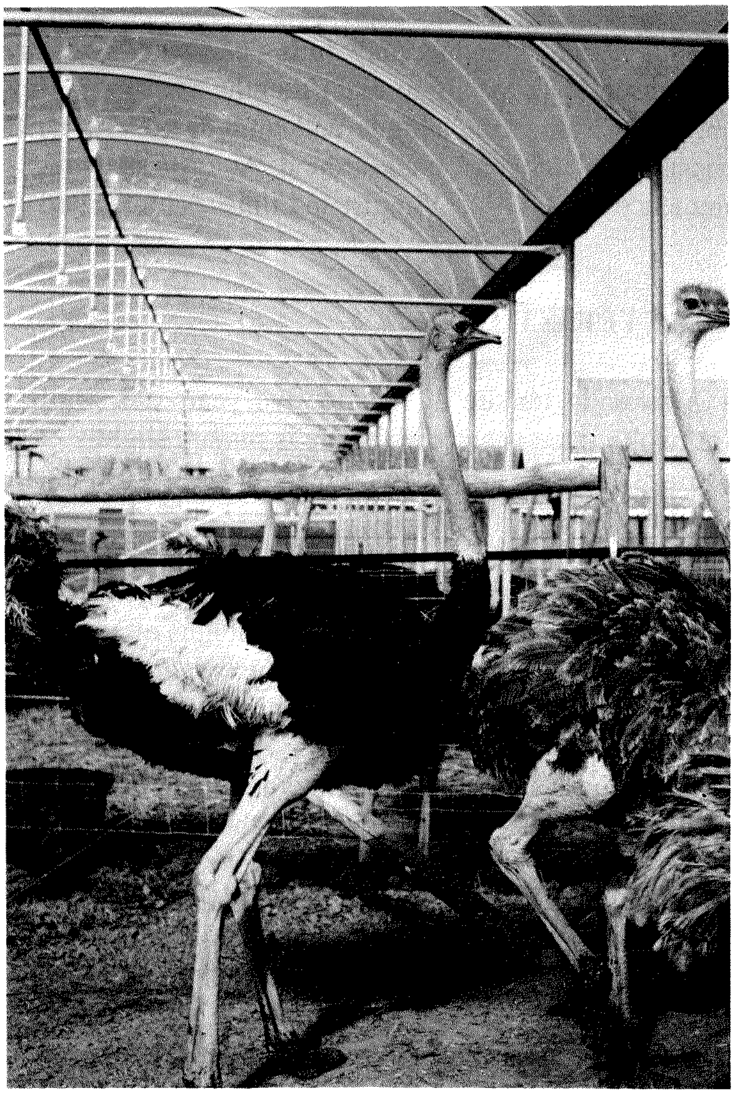
The plumage of the cock is brighter during the breeding season. The skin, usually light blue, becomes bright red over the beak and forehead and around the eyes. The leg scales and toes become pink (Figure 34).

The male and female chicks are very alike and their sex can only be determined by examining their sexual organs. This is difficult as the penis of the male is still tiny and can be easily confused with the clitoris of the female. From about seven to eight months of age, sex can be determined when the bird urinates or defecates, since the penis emerges at these times. Unlike most birds, the male ostrich has a penis and micturition and defecation are separate acts (although one normally follows the other almost immediately).

Full distinction between the sexes is reached at about two years old. The wing quills are pure white in the male, while they are ringed with grey or black in the female. The tail feathers of the male are white or yellowish brown and those of the female are mottled light and dark grey.

It is important to note that the scarlet coloration of the male's peak and skin is dependent upon the presence of mature testes, while its black plumage is dependent upon the absence of ovaries (the oestrogen hormone in particular). A castrated cock never acquires scarlet coloration, but its feathers are the normal black of the male. Removal of the testes after sexual maturity has little effect on the bird's sexual instincts, and it will continue the mating procedure.

FIGURE 34
Male coloration during the breeding season



NEST BUILDING

The male begins the process of nest building well before mating. To call an ostrich nest "a nest" is most certainly being overcomplimentary, especially considering the time and effort other birds put into building their nests. The ostrich nest is merely a simple shallow scrape or depression in the ground. The male selects a site and scrapes irregularly with his feet and then sits down and pecks at the nest, seldom digging with his beak. As the male scrapes, the female lies behind him and scratches with her feet. She shows her acceptance of the nest by lowering and fluttering her wings.

The nest can be situated anywhere in the breeding paddock. Most sites are on open land with a good view, often at the edge of treeless drainage lines, usually roughly in the centre of the paddock or territory. Since the eggs will be frequently collected and removed (in the case of artificial incubation), the position of the nest is of great practical importance. The producer can "assist" the male in choosing the "ideal" site for the nest by opening or digging out a shallow hole in the ground and filling it with coarse sand. The floor or bottom of the nest should be flat to prevent the eggs from rolling and knocking against each other. Furthermore, a small bank should be built around the nest (on the outside) to prevent any water from entering and submerging the eggs before collection. If desired, the nest may be raised slightly above ground level, by using coarse sand underneath.

A pitched roof open-ended shed (or a short polytunnel) can be made to cover the nest. This should be about 3 x 3 m with a height of 3 m and with the open ends facing north and south. However, some birds may not accept this foreign structure and may prefer their own simple nests instead. Alternatively, mounds of sand can be deposited at various strategic places in the breeding area to attract the birds to adopt one to make their nest.

A method sometimes used to encourage females to lay their eggs on a particular site is to place decoy wooden eggs in the preferred nest(s). These act as an irresistible stimulus, particularly for minor hens, to lay (see Egg laying section p. 62).

MATING BEHAVIOUR

Male ostriches are polygamous and can mate with more than one female. In the wild, the cock starts nesting with one, two or more hens. Domesticated ostriches are kept in pairs (one male and one female) or in trios (one male and two females) for the breeding season.

Courtship display in the ostrich is both complex and intriguing. A female ready for mating will approach a male with her head down low, her wings partly spread and the tips gently vibrating (Figure 35). The male responds by lowering his wings and tail and raising and lowering his head and neck. After this, the female will often turn and walk slowly away. Part of the courtship display in ostriches involves the "rolling" of the male. He squats down on his haunches and raises his wings backwards and forwards while hitting his head on each side of his back, making a thudding sound. In captivity, males frequently display to any visitor approaching the enclosure. Usually silent, the male call

FIGURE 35

A female ready for mating partly spreads her wings and then goes down on the ground

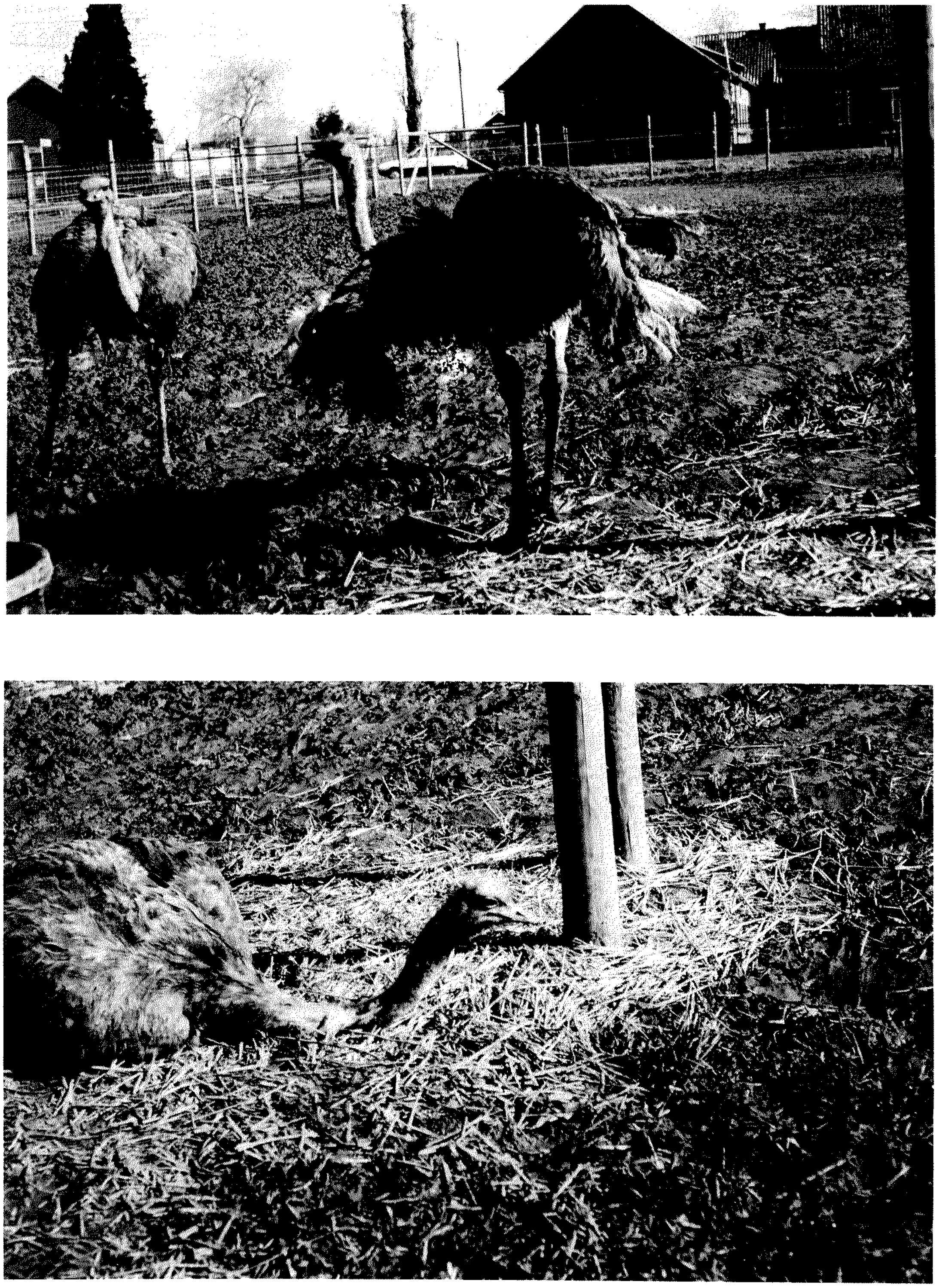
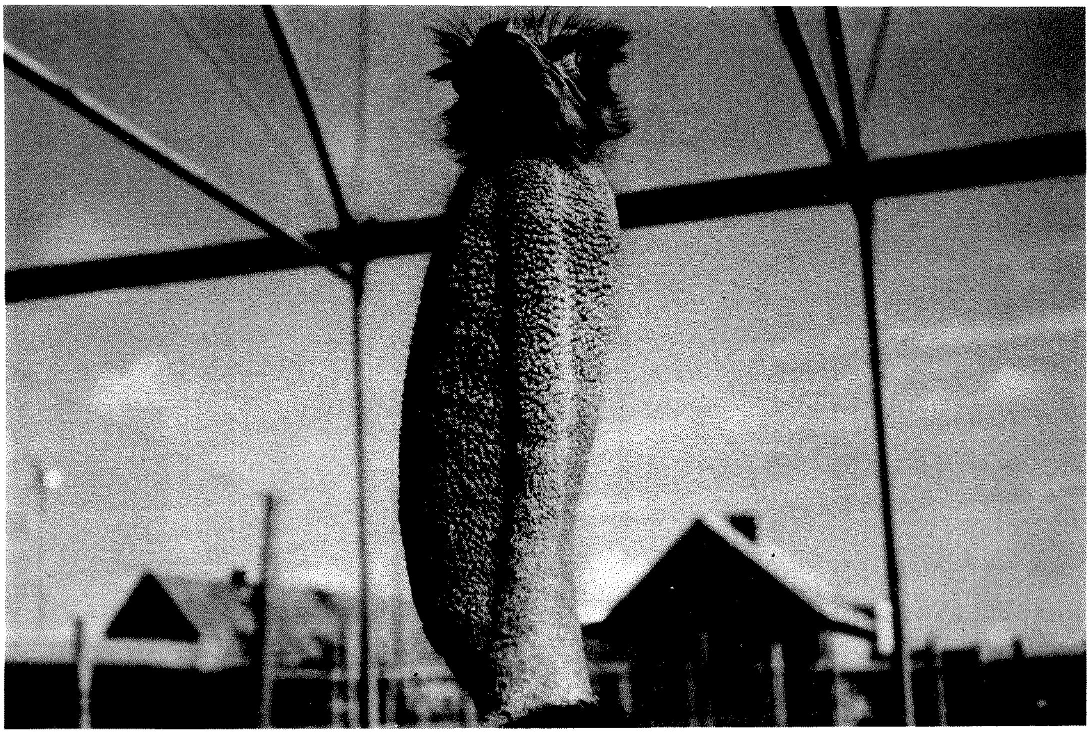


FIGURE 36
The male call is a hollow booming sound, made by filling the cervical air sac with air



in the breeding season is a hollow booming sound made by filling the cervical sac with air (Figure 36). The female holds her wings horizontally and flutters the tips. Her head is held low, and she opens and shuts her beak. When she is crouching, the male places his left foot next to her and mounts with his right foot on her back (Figures 37 and 38). He drops gently on to her back, and the phallus or penis passes into the cloaca of the female. After penetration, the male rolls or sways rhythmically from side to side, vibrating his wings. Consummation is usually accompanied by his rhythmic grunting or groaning, snapping of the beak and partially inflating upper neck, while the female snaps her beak and shakes her head. When semen is transferred (ejaculation), the male makes a guttural sound. Full copulation takes one minute, after which one or both stand up (normally the male first). The male's penis is engorged when withdrawn, and is visible when he stands (Figure 39).

FIGURE 37
Mating in ostriches - the male drops gently on to the female's back

The male places his left foot next to the female, with his right foot on her back

FIGURE 38
Mating in ostriches - after penetration the male sways rhythmically

Consummation is accompanied by partially inflating the upper neck

FIGURE 39
After copulation the male's phallus becomes visible when he stands

EGG LAYING

The female starts to lay fertile eggs shortly after mating. The first fertilized egg is laid approximately 10 to 14 days after first mating. Thereafter, and almost without exception, eggs are laid every other day in clutches (sequences) of 20-24 eggs. The hen stops laying for a period of seven to ten days after which she starts a new clutch again. Between 80 to 100 eggs are laid during the breeding season by high-producing females; up to 167 consecutive eggs are recorded without a visible off-season. In any given breeding season, the females "come into season" before the males so that early eggs are very likely to be infertile.

The eggs are laid in a communal nest on the ground. The first female to lay in the nest is normally the one that subsequently undertakes the guarding and incubating, and is termed the "major hen". Any bird that lays in another female's nest is called a "minor hen" because of the minor role she plays. While minor hens may lay their eggs in several nests, a major hen will only do so in one nest. Compared with the minor hen, the major hen will spend a relatively longer time at the nest, and will attend to the nest daily even on the days she lays herself. When a minor female arrives, the major female "gets up" usually within a few minutes, and waits 5-20 m away from the nest until the minor female has laid and left.

A minor female about to lay will stand at the nest for a few minutes and move its head up and down among the eggs. It will then raise its tail and sit down abruptly. It remains sitting for one or two minutes, during which time it lays an egg. Once the egg has been laid, the female stands up, her head again down among the eggs for a few minutes, and then she walks away. Of the females, a major hen is able to recognize her own eggs and, if too many eggs are laid, she will roll those that are not hers out of the nest.

Similar only to the quail, ostrich egg laying takes place during the afternoon. Laying time varies with latitude, and generally ranges from 1400 to 1800 hours; a few eggs may be laid after 1800 hours.

If the eggs are not removed, the female will start incubating them during the day, leaving the male to incubate them from dusk to dawn. The male's jet black feathers help to hide the eggs during the night. In commercial ostrich farming, all eggs should be removed from the nest at least twice daily. If the female is allowed to incubate, she will stop laying until the chicks have reached four to five weeks of age, with a consequent financial loss.

MAJOR FACTORS AFFECTING EGG PRODUCTIVITY

Many factors influence the number of eggs produced in any given season; some are environmental while others are inherent to the individual bird.

Inheritance (or genetics)

Inheritance or the genetic makeup of the bird plays a fundamental role in productivity. Differences between subspecies in age at sexual maturation and in their ability for egg laying have been noted in the wild. No direct comparison, however, has been made between the various ostrich subspecies or their crosses in captivity (under similar management practices). The North African ostrich (or its crosses) appears to be the lowest egg producer, with an average of 32 eggs produced per season, ranging from 10 to over 80. The Domestic ostrich, at the other extreme, produces an average of 60 eggs, ranging from 25 to more than 100 eggs. Egg productivity *per se* is not the only factor that should be considered when choosing between races or crosses but rather a combination of productivity, fertility and chick survival rate.

The duration of breeding is also influenced by genetics. In the wild, ostriches are generally known to be opportunistic breeders; for example, breeding may be triggered off by a short rainfall. The onset and termination of breeding varies, to a limited extent, among subspecies. Laying persistency, therefore, varies between races and their crosses.

Age

Egg productivity in ostriches appears to be age related. In the first breeding season it is usually low. However, as the birds get older, their egg production increases. During the first season, eggs are laid in two distinct cycles (sequences or clutches). Each of these cycles is fairly short, which results in a total of 18-20 eggs per cycle; the first cycle is normally slightly longer than the second. As the birds grow older two main changes take place: the cycle length increases and the number of cycles increases from two to three and sometimes even four cycles per season. The result is a gradual but clear increase in productivity with age. With proper management, some birds are known to have five laying cycles per season, producing over 100 eggs.

Environment

Severe weather or climatic fluctuations influence the level of productivity. This influence is more pronounced during the second or third cycle. Heavy rain or sudden cold spells adversely affect laying ability and birds may go off laying during such periods. There appears to be a degree of interaction between climate and the productivity of ostrich races. Productivity of the "red-neck" races, particularly the North African ostrich, is noticeably much lower in areas with fairly continuous rainfall.

As noted in Chapter 3, light affects both rate of sexual maturation and duration of the breeding season. The proper use of supplementary artificial lighting can revolutionize ostrich production and significantly enhance egg productivity.

Nutrition

The feed consumed by the ostrich hen is used mainly for maintenance and egg production. If there is a marked deficiency in any of the required nutrients, egg productivity will decline or even stop completely. Calcium, in the form of calcium carbonate, is the chief constituent of the eggshell. Thus the level of calcium must be increased in the diet prior to the onset of breeding to allow for normal production of eggs and their shells. Deprivation of supplementary calcium or vitamin D_3 also causes a marked drop in egg numbers.

Although nutritional deficiencies may cause a decrease in productivity, excessive feeding is just as detrimental. Obesity is one of the main causes of decreased ostrich production.

Health

The general health of the flock affects egg productivity. Many diseases and parasites interfere with the normal development of the egg and hence affect both egg numbers and egg quality. If the oviduct is not properly formed, ostrich hens may ovulate internally. The infundibulum fails to engulf the ovulated ova, which then remain in the abdominal cavity. Such hens develop a pot-bellied appearance and are normally termed "internal layers".

Prolapse of the oviduct (or just the vagina) is another condition associated usually with young females in their first season. In addition, some hens may become "egg bound" in that they are unable to deposit or expel the completed egg. The egg may not always be palpable in the caudal abdomen and ultrasound and/or radiology may be required for proper diagnosis.

Psychological factors

Stressful conditions can affect a bird's productivity and should be avoided at all times. Breeding birds should be introduced to their breeding paddocks at least 30 days before the onset of laying. This period of time is important to allow the birds to settle down and become familiar with their surroundings before breeding begins. Moving the birds during the season will almost certainly reduce their productivity until they settle down and get used to their new paddocks.

The regular removal of eggs is of paramount importance for the continuation of egg laying. Failure to do so on a regular basis may lead to the complete cessation of egg laying for a considerable time. It is also important that the eggs be collected with minimum disruption.

If the colony mating system is practised (where more than one male is kept in the paddock), the location of water and feed containers or troughs in the breeding paddock is of some importance. To avoid excessive fighting and harassment, water and feed should be conveniently located throughout the paddock.

THE OSTRICH EGG

As befits the largest bird, the ostrich lays the largest egg of any living bird. Oddly enough, however, the ostrich egg is one of the smallest in relation to the size of the bird. Measuring, on average, 17-19 cm in length and 14-15 cm in width and weighing up to 1 900 g (Table 8), the ostrich egg is only just over 1 percent of the female's body weight.

The eggs vary from white to yellowish white; their hard shiny surface is pitted with superficial pores of various sizes and shapes.

There are significant differences in ostrich eggs between subspecies and localities. Ostriches from various areas appear to have a characteristic average egg shape and size. This may be attributed to variations in body dimensions of the birds; egg size is highly correlated with body size. The largest eggs measured are from the Masai ostrich of East Africa, while the smallest are from the arid regions of the west coast of South Africa.

FACTORS AFFECTING THE FERTILITY OF BREEDING OSTRICHES

Breeding is an integral part of commercial ostrich farming, whether on a large or a small scale. The number of chicks that hatch from a given number of eggs depends largely on the fertility of the breeding flock and the storage and incubation conditions of the eggs. The two latter factors will be dealt with in the next chapter. The percentage of infertile eggs in breeding ostriches is quite high when compared with most domestic birds. At present, infertile eggs average 42 percent in the United States, with a slightly lower percentage in Europe, which represents a significant loss at today's market value. This section is solely devoted to discussing the factors that affect fertility in breeding ostriches, because of its economic importance.

Problems of infertility are most likely to occur in individual flocks. Infertility is established by examining the eggs (without breaking them) by candling. At candling the infertile egg will appear "clear" if it does not contain a living germ cell. Egg candling is

TABLE 8
Physical characteristics of average ostrich, chicken and quail eggs

	Ostrich	Chicken	Quail
Egg weight (g)	1 522	57	10
Albumen (g)	904	32.5	5.6
(% egg)	59.4	57.1	56.5
Yolk (g)	318	17.7	3.3
(% egg)	21.0	31.1	32.6
Shell (g)	297	4.9	1.0
(% egg)	19.6	8.6	9.9
Shell thickness (mm)	310	0.31	0.19
Egg shape index	82.8	73.3	78.3

done successfully in ostriches on day 14 of incubation. It is important to be able to distinguish between infertile eggs (that have never contained a living germ cell) and eggs with early embyronic death (eggs that had germ cells but that have died early). To do this, the eggs need to be candled as early as possible after incubation begins. It is better practice, therefore, to candle the eggs initially on day 6 or 7 of incubation and again on day 14. If candling proves to be unsuccessful, particularly in view of the fact that ostrich eggs possess thick shells, then all unhatched eggs at the end of incubation should be broken, examined and classified. Causes of "true" infertility may be caused by one or more of the following factors.

Male:female ratio

Although a ratio of one male to one female (1:1) appears at first to be ideal for highest fertility, compatibility may prove to be a problem. Incompatible pairing is a problem that sometimes occurs when birds are not allowed to select their mates. However, as such a "natural selection" of mates is not normally possible in commercial operations, the producer should spend extra time observing the birds after grouping and should take a constant note of their performance and compatibility.

Male:female ratios from 1:2 to 1:4 appear to give comparable and satisfactory fertility rates. A ratio in excess of 1:4 is not desirable as the male may not be able to mate with all the females and this in turn may result in a higher number of infertile eggs.

Mating system

Regardless of the ratio of males:females, the mating system used can influence the level of fertility obtained. Mating systems can be divided into two types depending on the number of males per breeding paddock:

- single mating system where there is only one male; and
- colony mating system where there is more than one male in the paddock.

The single mating system is useful if breeding records are to be kept for the later sale of particular males or of the group as a whole (as a trio, for example, in the case of one male and two females). One problem that may arise from the use of such a system, and that may lead to impaired fertility, is termed "preferential mating". This is the tendency of the male to mate more often with certain females in the group (particularly when the choice is great), or when the female refuses to squat and mate. If such a system is preferable, and if preferential mating has been observed, then the males should be rotated (although this in itself may cause some stress and may interrupt egg laying for a time).

The colony mating system is recommended in order to avoid such problems. The females will walk between each male territory and hence have a better chance of mating. One thing to remember is that ostrich males are aggressive and tend to fight, at least until each has defined his own territory (there are no physical boundaries between male territories but only those recognized between the males). Putting too many males together may lead to extensive fighting and a subsequent reduction in fertility. Depending on the size of the breeding paddock, three to four males are about the correct number per unit. This number can, however, be increased where paddocks are very large (see next section).

Age of breeding birds

As with egg productivity, the age of the birds affects fertility rate. Very young males, although exhibiting the appearance of the breeding condition, are often not sufficiently dominant to mate successfully and frequently.

As stated earlier, the ostrich breeding season lasts for six to eight months every year and the timing depends upon the latitude between the northern and southern hemispheres. Season infertility is common early in the breeding season with the females coming into production 7-14 days before the males have mature spermatozoa. Within each breeding season, fertility increases to reach a maximum around the middle of each laying cycle or clutch, after which it declines gradually. The number of infertile eggs produced in the last laying cycle is higher than the number earlier in the season. Generally, however, fertility for the whole season increases as the birds get older. This continues until a maximum plateau is reached and remains so for a number of years after which it gradually declines. This decline is primarily caused by loss of vigour, reduced mating frequency and a decline in the number of sperm produced at each mating with the passage of time. Because of lack of research, the years (or seasons) with the highest fertility rates cannot be clearly defined. Under good management practices, fertility of breeding flocks is at its highest from about the fifth to the twentieth season.

Inheritance (genetic factors)

There is great variation in inherent fertility between ostrich subspecies and crosses. As in domestic fowl, semen production in ostriches appears to be inherited. From the few published reports on the subject, the males of the "red-neck" ostriches (the North and East African subspecies) are slightly more virile, aggressive and dominant. The egg fertility of these birds is slightly higher and the males can mate successfully with more females than either the Somali or South African male ostriches. Unfortunately, no comparison has been made on semen quality between subspecies.

Nutrition

The nutrition of growing ostriches and adults is important for achieving maximum reproductive performance. Gross or marginal deficiencies in either the quantity or quality of food can adversely affect fertility. Starvation for six days can lead to a marked drop in semen production in the male because of its failure to secrete sufficient quantities of certain hormones (gonadotrophins). When dietary deficiency is marginal, an ostrich hen can produce almost its own weight of eggs in the breeding season, but a cock cannot produce the quantity of semem needed to fertilize them all.

Calcium has a profound effect on the function of the reproductive organs, especially in the female. Males are obliged to consume diets containing 3-4 percent calcium, intended mainly for laying females. Calcium can interfere with the absorption of some dietary constituents, particularly zinc, from the alimentary canal. Deficiencies of this trace element can lead to retardation in the development of testes. Once the breeding season is over, it is recommended that the males be separated and fed on diets low in calcium until the next season. Young males should also be fed separately until they begin to show breeding signs and before they are allowed to mix with the females. This will ensure that development or regeneration of the testes proceeds at the normal rate.

Deficiencies of vitamins A and E and selenium have also been linked to infertility.

Health

It is obvious that a sick or poor bird has no hope of breeding. A poor condition may result from internal parasites, such as nematodes, which are a common cause of infertility. The physical presence of the worms can debilitate the birds by cutting down their food intake, but more commonly cause secondary deficiencies of vitamins and other nutrients. Birds that appear at a casual glance to be in perfect health and in good breeding condition may have some underlying chronic disease that renders them infertile. Avian tuberculosis, aspergillosis and coccidiosis are common in places where birds (of any type) have been kept for some years. Mycoplasmosis is known to adversely affect fertility.

Injury to feet, wings or head can also prevent successful mating and thus affect fertility of eggs.

There is a percentage of intersexes in ostriches. As explained earlier in this chapter, the black coloration (or pigment) of the male's feathers is caused by the absence of the high circulating oestrogen hormone produced by the ovary. A mature male with full black feathering and which sexes cloacally as a female will not reproduce and may have either inactive ovary, testes, or both. Anatomical causes of infertility include deviations in the male's phallus that do not allow copulation. Prolapse of the phallus is occasionally seen during the breeding season and during extreme weather conditions. If allowed to persist, this may damage the phallus.

Artificial insemination

Artificial insemination (AI) is one of the most important techniques for the genetic improvement of animals. Methods have been developed for inseminating cattle, sheep, goats, swine, horses, dogs, poultry, primates and many laboratory animals and insects. Basically, AI involves several steps: semen collection, semen evaluation, semen preservation and dilution and, finally, insemination of females. Several attempts are being made in the United States to develop a successful method for AI in ostriches. Although it may be some time before a successful method is reached, there will eventually be great advantages for the ostrich industry.

Environmental factors

Most birds are stimulated to commence breeding by a change in the length of daylight. This is also the case in ostriches. With an increase in day length, the entire metabolism of the bird (whether male or female) is changed to make the necessary nutrients for the formation of eggs and sperm available. Lighting programmes can be used to accelerate sexual development, extend the breeding season and improve fertility in ostriches.

Extremes of ambient temperature and rainfall also affect fertility either indirectly by influencing feed consumption or directly by reducing the frequency of mating. High voltage power lines and the presence of predators and field equipment may interfere with normal breeding behaviour. Overcrowding can lead to low fertility by the physical reduction in available space necessary for courting and successful mating.

THE BREEDING PADDOCK

Generally speaking, the larger the paddock the better. However, since a large area is undoubtedly more costly, common sense should be exercised when deciding on how large or how small the breeding paddock should be. The Royal Society for the Protection of Cruelty to Animals (RSPCA) of the United Kingdom recommends no more than 12 adult birds per acre (0.4 ha). This figure represents the upper limit and is not necessarily the optimum number. Ostriches are lovers of space and prefer large breeding areas. Clearly, farmed ostriches cannot be provided with very large areas (unless land prices are low), but they should have sufficient space in which to forage, walk, run and display courtship when they wish. Accordingly, a minimum of 0.1 ha (0.25 acre) paddock is needed for two to three adult ostriches in breeding (one male and two females). If larger numbers are to be kept in one paddock, then the paddock size should be increased exponentially (i.e. a minimum of 0.3 ha/0.75 acre for four to six birds, 0.6 ha/1.5 acres for 8-12 birds, and so on). Ostriches are likely to breed better if provided with more than the minimum space.

Good, well-drained and, where possible, sandy paddocks should be chosen as ostrich breeding areas. The breeding paddock must be enclosed by a hedge or a wooden/wire fence at least 1.5 m high. Furthermore, it is preferable for breeding paddocks to have rounded corners or baffles to reduce collisions. It is also advisable to make a passage between paddock fences (1.8 m wide) to prevent males from fighting (see Figure 40); a hedge between fences is ideal.

COLLECTION AND STORAGE OF EGGS

Hatching eggs are often collected and stored for a time before incubation. This is a normal practice, particularly in commercial enterprises where eggs are kept until there are sufficient numbers to fill the incubator(s). It is unusual for eggs to be collected and set daily, unless it is economically profitable for some reason.

Proper handling of eggs prior to incubation is as important as incubation itself if the highest hatchability is to be obtained. Rough handling of hatching eggs can disrupt the delicate internal structure and will lead to the death of the embryo. When eggs have been transported and shaken about, it is highly advisable to allow them to settle for 24 hours before being set.

Egg collection

A perfectly hatchable egg may be ruined before it is even set, by bacterial contamination. Bacteria can pass through the pores of the eggshell within three to four hours of the egg being laid. Entry is greatly speeded up if the shell is wet or dirty. When the egg is first laid it has the ostrich hen's body temperature but cools rapidly. This cooling causes the egg content to shrink and decrease slightly in volume. Since the shell does not contract as much, a vacuum is generated in the egg and air and bacteria are drawn in through the pores, forming what is known as the air cell or sac. Bacterial contamination of hatching eggs can be greatly reduced by adopting the following guidelines for collecting and handling eggs:

- Collect hatching eggs at least twice daily and more frequently at high temperatures.
- Use clean containers for egg collection.
- Clean dirty eggs as soon as possible after they have been laid.
- Avoid wiping the eggs with a dirty damp cloth since this is the fastest way to contaminate them. Use dry fine sandpaper for cleaning off large lumps of dirt.
- When washing the eggs, follow the manufacturer's instructions explicitly with regard to the concentration of either the detergent disinfectant or formaldehyde.
- Ultra-violet lighting (in the range 200-300 nm) is effective as a germicidal technique.
- Cool the eggs gradually before packing for storage.
- Avoid water condensation on eggs when traying.

FIGURE 40
A passage at least 1.8 m wide should divide paddocks to prevent males from fighting

Storage period of eggs

From the moment it is laid, the egg begins to deteriorate physically, and is also subject to bacterial attack. For these reasons eggs cannot be stored indefinitely prior to incubation but only for a very short period. An egg will remain hatchable up to a certain point of deterioration, beyond which hatchability falls off rapidly. Under optimum storage conditions, hatchability of ostrich eggs begins to fall after five days, by an average of 2 percent per day. It is therefore not advisable to store the eggs longer than one week.

Optimum storage conditions

It is known that the rate of deterioration in the egg after laying depends on the storage environment. Degradation and decay, which take place inside the egg during storage, are temperature sensitive. In addition, the development of the germinal disc on the upper surface of the yolk stops when the egg is cooled after laying to 21-23°C (70-73°F). This temperature is referred to as the "physiological zero" and at temperatures above this growth recommences very slowly. The growth is weak and, if prolonged, the embryo either dies or is so weakened that it does not survive one of the major developmental changes in its later growth. Similarly, storing eggs at a very low temperature for long periods can easily lead to embryonic death.

The rate of water evaporation from the egg depends, among other things, on temperature and humidity. If the egg loses too much water by evaporation during storage, the embryo is unable to develop properly and may eventually die before the egg is put in the incubator. At normal room temperature (23-33°C), an ostrich egg will lose approximately 1 percent of its weight in one week. This amount of water loss is notably low compared with chicken eggs, because ostrich eggs have thicker shells (and a lower functional pore area). Table 9 shows the recommended storage conditions for ostrich eggs.

The eggs should be stored with the narrow (pointed) end down and turned through 45° (on the vertical axis) twice a day, normally in the morning and evening. It is crucial to avoid relative humidity of 85 percent or more, since bacteria can pass easily through the shell pores because of condensation of atmospheric water vapour if dew point is reached. Furthermore, for long storage periods (over seven days), and in order to minimize air movement around the eggs, thus avoiding excessive water loss, it is best to cover them with low-permeability polyethylene films or cryovac (polyvinylidene chloride copolymer resin) bags. Plastic packing of eggs is particularly beneficial where higher environment temperatures prevail, such as may be experienced during transportation.

TABLE 9
Optimum storage conditions of ostrich eggs

Storage period (days)	Temperature (°C)	Relative humidity (%)
1-3	18	75-80
4-7	16	75-80
> 7	15	75-80

The egg albumen starts to break down and becomes more alkaline immediately after the egg is laid. The rise in pH is caused by the loss of carbon dioxide from the egg. Plastic enclosures, therefore, inhibit or reduce the escape of carbon dioxide from the eggs. Since cryovac is impermeable to carbon dioxide it provides more positive inhibition while low-permeability polyethylene films provide sufficient inhibition of carbon dioxide loss to permit only a slow rise in albumen pH. It is critical to note that in order to obtain the full beneficial effects of plastic enclosures, eggs should be covered as soon as possible after collection.

The initial stages of embryonic development occur during the time it takes the yolk to pass down the oviduct, acquiring the different layers of albumen, membrane and shell. Cooling during storage prevents further progress, and the embryo lies dormant until it is warmed up again. The embryo can survive this treatment without harm. However, to be successful, the embryo should have grown as far as the "blastula stage". If the egg was retained in the uterus (shell gland) for too long (as it is the case with very large eggs), embryonic development would have reached a stage where normal cooling and storage would be lethal. Very small eggs, on the other hand, spend less time in the oviduct and hence are laid before reaching the blastula stage. Normal cooling and storage of these eggs would also be fatal to the embryos. Best hatchabilities are obtained with eggs in the range of 1 300 to 1 700 g.

Chapter 5

Incubation and hatching of ostrich eggs

NATURAL INCUBATION

Natural incubation in ostriches is shared between the male and the major female. The male incubates the eggs overnight, which represents about two-thirds of the 24 hours. The major female takes over from the male about two to three hours after dawn and leaves the nest one to two hours before dusk. The nest is seldom left unattended. The changeover is usually rapid and both birds are rarely present together at the nest; displays scarcely if ever occur.

The male loses the bright red neck flush, distinctive of breeding males, halfway through the incubation period. Furthermore, he will rarely interact with the females. Young males sometimes refuse to incubate but after a few days of irregular sitting they take up their task seriously.

The central temperature of naturally incubated eggs is maintained at 34-36°C, with a nest humidity of around 42 percent. These levels are made possible by the use of a temperature recording device inside a fibreglass dummy egg. Natural incubation lasts for 42 days, with hatching success reaching a maximum of 100 percent, for central eggs, in many nests.The male will often become impatient and crack the egg himself, shaking it until the chick falls out.

As noted in the previous chapter, the major hen can recognize her own eggs and, if too many eggs are laid in her nest, she will roll those that are not hers out of the nest. These "surplus" eggs can be easily seen, since they form an outer ring some 1-2 m around the nest. During incubation, the incubating birds turn the eggs inside the nest periodically, pushing some to the outside and bringing others to the centre. By doing this, it seems likely that the incubating birds are able to recognize infertile eggs and any eggs containing dead germ cells and thus roll them out of the nest to join those already in the outer ring. When a dummy egg is placed in the nest, however realistic it may seem, the incubating birds never fail to recognize it and it is discarded within a day or two from the beginning of incubation. This may explain the exceptionally high hatching rates obtained with natural incubation. Needless to say, none of the eggs in the outer rings ever hatch.

ARTIFICIAL INCUBATION

In order to incubate an egg artificially, the breeder tries to mimic nature, by providing the egg with all the conditions normally guaranteed by the parents. Since the advent of artificial incubation many years ago, and together with a better understanding of incubation in the wild, much progress has been made in clarifying the circumstances that contribute to the success (or failure) of fertile eggs to yield hatched chicks. The incubation period of ostrich eggs is 42-45 days and the actual process of hatching a chick is not at all simple. The environment in which eggs are incubated plays an important part, coupled with the position and turning of the eggs.

Incubation temperature

Maintenance of an optimum temperature is of prime importance for satisfactory hatching results. Embryonic development is initiated at temperatures far below the optimum, but only as the temperature approaches the correct level does hatching proceed.

Under natural incubation conditions with ostrich parents and in still-air incubators (with heat applied from above), where a temperature gradient exists with the maximum temperature at the top of the eggs, the optimum temperature at the upper level of the eggs is between 38 and 38.5°C. In forced-draft incubators, with uniform heat distribution around the eggs, the optimum temperature is evidently near the centre of the potential hatching zone, between 35.9 and 36.5°C. These are the very narrow limits of temperature between which the embryo will develop properly. Towards the end of the incubation period, when the chick begins to produce its own heat, the temperature can be lowered by 0.7°C (approximately four days before hatching).

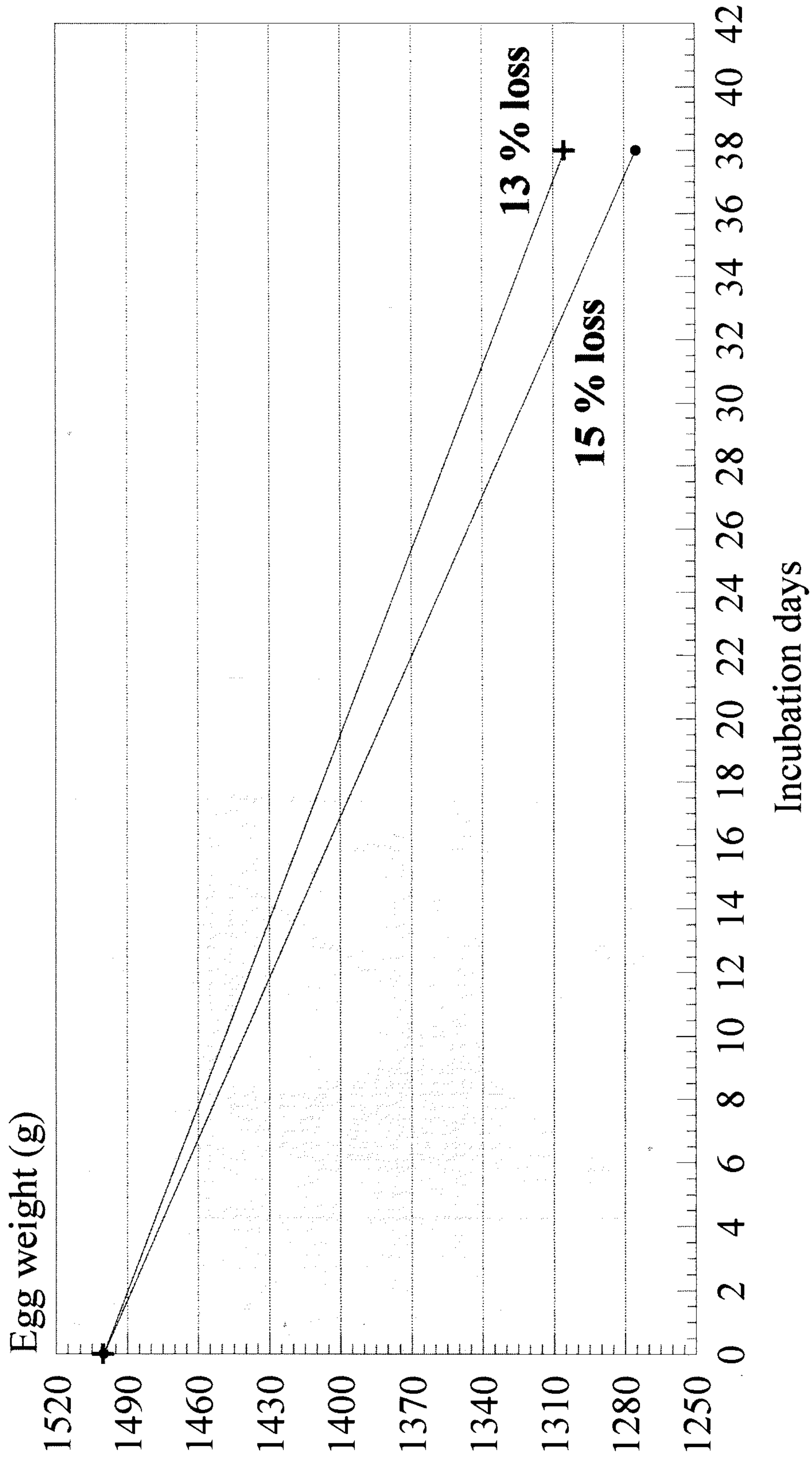
In the first few days, when the chick is being formed, minor changes in temperature can cause a great deal of harm, whereas in the later stages the same changes will have little or no effect except to alter the time of hatching. Changes in temperature often appear to cause no harm at the time, but late mortality will be high. If the temperature is too high all the way through incubation, it can be extremely damaging. Ostrich embryos will start developing, but a large number of them will die after three to four days. These can be seen on candling to have the characteristic blood ring around the yolk. Whereas marginally low temperatures will only delay hatching, significantly low temperatures, on the other hand, can prevent embryonic development altogether.

For a long time it was assumed, by analogy with conditions of natural incubation, that good artificial incubation results depend on the existence of a temperature gradient, decreasing from the upper to the lower surface of the eggs. For a time, this view had a great influence on the design of still-air incubators, but was shown to be without concrete foundation by the excellent performance of forced-draft incubators.

Humidity during incubation

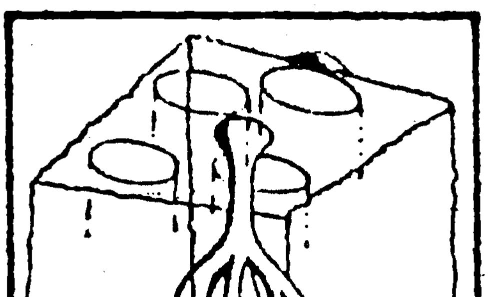
The optimum incubation temperature is not a constant, but varies with the humidity of the air. Eggshells are porous because developing embryos need to breathe (i.e. to take in oxygen and to eliminate the carbon dioxide produced). Gaseous exchange across the eggshell takes place by diffusion through the pores. The presence of pores in the shell, however, means that eggs lose weight continuously after being laid because water can escape from the egg contents. Weight losses from eggs during incubation are ascribed

FIGURE 41
Egg weight loss during incubation of a standard 1 500-g ostrich egg



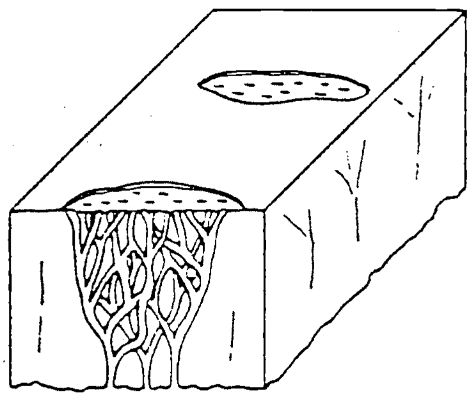
solely to the loss of water because embryonic respiratory gas exchange involves no overall weight change. Humidity itself is of great importance for an embryo to develop properly and to transform into a chick of normal size. For this to happen, the egg contents must evaporate at an established rate (13-15 percent of fresh weight to day 38 of incubation). An egg weighing 1 500 g at day 0 should lose on average 210 g by day 38 of incubation (38.7 g per week). Figure 41 is a simple graphic representation of weight loss to day 38 at a constant rate. If the rate of evaporation is high, the egg contents dry out too rapidly and the chick will be smaller than normal. On the other hand, if evaporation is not fast enough, the chick will be larger. In either case the embryo is weakened, resulting in reduced hatchability or poor-quality chicks, or both. To control the rate by which the egg contents are evaporated, moisture content in the air surrounding the egg must be controlled, as it is this outside moisture that determines water loss from the egg. Too little moisture in the early stages results in excessive shrinkage of the egg contents, and the embryo is unable to mobilize the calcium from the shell for bone growth. In addition, the developing kidneys will have insufficient water to excrete the waste products. Most of the chicks will die at about the time they are due to start pulmonary respiration. Too much moisture results in a small air cell, excess amounts of albumin and a soft chick. Many eggs will fail to hatch and if opened (at the end of hatching), the excess albumin will pour out of the egg.

FIGURE 42
The extensive branching of pores in ostrich eggshells (*Source*: Board, 1982)



Ostrich eggs require a lower relative humidity (RH) than chicken eggs for optimum hatching, notably at the beginning of incubation. Unlike the majority of eggshells (where the shell pores are unbranched and funnel-shaped), ostrich eggshells have multiple-branched pores with extensive branching along both axes of the egg (Figure 42). The external pore openings are clustered in saucer-shaped depressions in the outer shell surface (Figure 43). This structure is very similar to the eggs of the extinct Elephant bird with the exception that branching of the latter is not so extensive as in ostrich eggs. Because of the complex branching of the pore canals of ostrich eggshells, eggs do not lose water easily and thus require much lower humidity during incubation. High hatching rates in ostriches are obtained with 15-25 percent RH (at 36°C).

FIGURE 43
The saucer-shaped external pore openings of ostrich eggshells (*Source*: Tullet, 1984)



Shell characteristics are maternally specific. However, when confronted with a change in environmental conditions, the female bird is capable of quite rapid changes (within seven to ten days) in eggshell characteristics. Minor modifications of the artificial incubation technique is called for if eggs are transferred to high altitudes, to allow for the increased rate of water evaporation from the eggs (as a consequence of low atmospheric humidity) and for reduced oxygen pressure. At a latitude of 2 000 m, a 3 percent increase in RH and a 0.8°C rise in temperature should bring about the necessary compensations.The introduction of supplementary oxygen into the incubator over the entire period of development may also prove essential to maintain high hatchability.

Ventilation (gas exchange)

Poor ventilation and air movement inside the incubator may result in an uneven distribution of heat and moisture, a lethal carbon dioxide level and an insufficient oxygen supply with poor hatchability as the net result. The developing embryo is normally capable of withstanding marginal reductions in oxygen levels down to 18 percent. It is generally agreed, however, that a drop in hatchability in the order of 4-5 percent is expected for every 1 percent drop in oxygen level below 18 percent. A high concentration of carbon dioxide inside the incubator is extremely damaging.

Egg position and turning

The position of eggs and turning are further important factors during artificial incubation. The part of the yolk that is in contact with the germinal disc is lighter than the rest of the yolk, so at all times it tends to float to the top. Each movement of the egg tends to bring the germinal disc into contact with fresh nutrients. This is of paramount importance before the embryo has developed a blood circulation that will bring nutrients to it. Failure to turn the egg can thus deprive the embryo of nutrients and oxygen at a critical stage in its development.

The yolk as a whole is also lighter than the albumin (because of its high lipid content) and tends, therefore, to float to the upper surface of the egg. It is only the yolk ligaments (chalaza) that delay, but do not stop, its movement to the top surface of the egg. If not turned to a new position frequently, the developing embryo touches the shell membrane and sticks to it. This could be fatal to the embryo as it hampers its movement inside the egg.

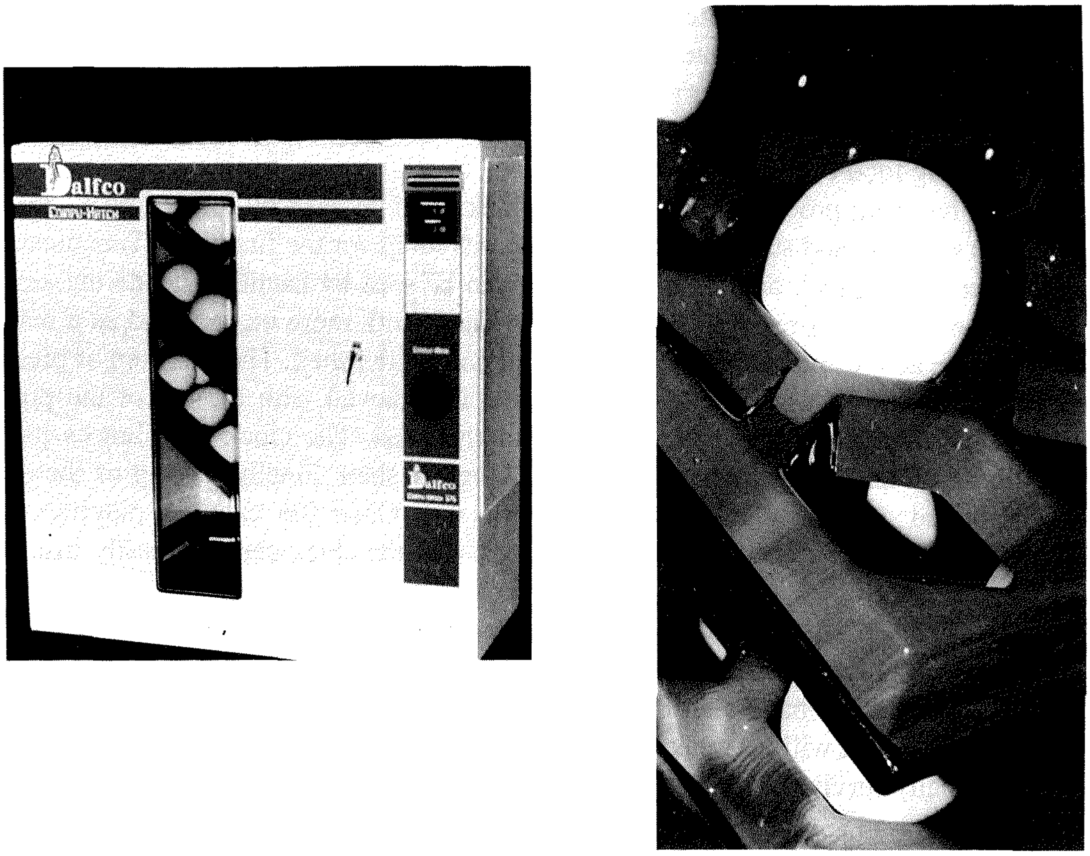
The embryo takes up a definitive position for each incubation stage. Turning of the egg is necessary to help these movements within the egg (Figure 44); without doing this, the embryo will remain in the wrong position and in many cases the chick will not emerge successfully from the egg at hatching time.

Under natural incubation conditions, the ostrich hen or cock moves and turns the eggs, on average, once every 20-30 minutes, i.e. 48-72 times in 24 hours. Eggs under artificial incubation should be held with the large ends uppermost. Turning should be carried out at least three times a day if done manually (more, if possible, but always an odd number of times, e.g. five, seven, nine, etc.), or once every one to two hours if done mechanically. Egg turning should stop at day 38 of incubation. Eggs are then transferred to the hatching trays.

Other factors influencing hatchability

Once the egg is laid, nothing of course can be added to it. For the embryo to develop properly and successfully the egg must have all the nutrients needed for this process within the shell. A deficiency in the hen's diet will cause defects in the growth of the embryo and may also cause its death. Nutrient requirements for breeding ostrich stocks are discussed in Chapter 7.

FIGURE 44
Egg turning during incubation *(courtesy of Dalfco Systems, Canada)*



Hatchability from weak or diseased birds is expected to be poor. Apart from affecting the general condition of the hen, a disease may also prevent her from transferring vital nutrients to the egg. Viral and bacterial infections are known to cause poor hatchability even after the apparent recovery of the birds. Of the bacterial infections, Pullorum disease and disorders brought on by the other salmonellae are known to exert a great influence on hatchability. In addition, under certain conditions bacteria of the alimentary tract and skin of hens, belonging chiefly to the coli-erogenous group, may penetrate the shell and can, on reaching the yolk sac, become pathogenic, causing embryo mortality especially during the first two days of incubation.

HATCHING

The eggs are transferred to the hatching trays in the hatching compartment (if setting and hatching are carried out in one machine) or in the separate hatchers. This is normally done at day 38 of incubation. The chick draws the yolk sac inside the body during the last 24 hours of incubation, which acts as a food store after hatching for the first few days of its life. It is the presence of this yolk sac that enables chicks to be transported for several days without needing food or water.

The hatching process starts when the chick jerks its head by reflex, breaks its way through the allantois and starts to breathe through its lungs for the first time. This process is called "internal pipping", and the chick's beak can be seen by candling inside the air cell. The changeover to lung respiration supplies the chick with more oxygen and as a result it becomes more active and is able to break a small hole in the shell. The first step of breaking the eggshell is known as "external pipping" and is achieved with the aid of the pipping muscle, which develops dorsally at the base of the head. The chick then braces its legs against the shell and turns around the egg, pecking the shell. Finally the top of the egg is neatly removed and the chick emerges (Figure 45). Once the external pipping starts, humidity should be increased by 3 to 5 percent so that the chick can turn easily inside the egg.

The hatched chicks should be left inside the hatcher until completely dry before being removed; 24 hours will normally suffice. Many ostrich producers are anxious to help the chick to get out and break the shell too early. This kind of temptation should be avoided as the chicks hatched will be weak, prone to infection (particularly yolk sac infection), and will not normally survive.

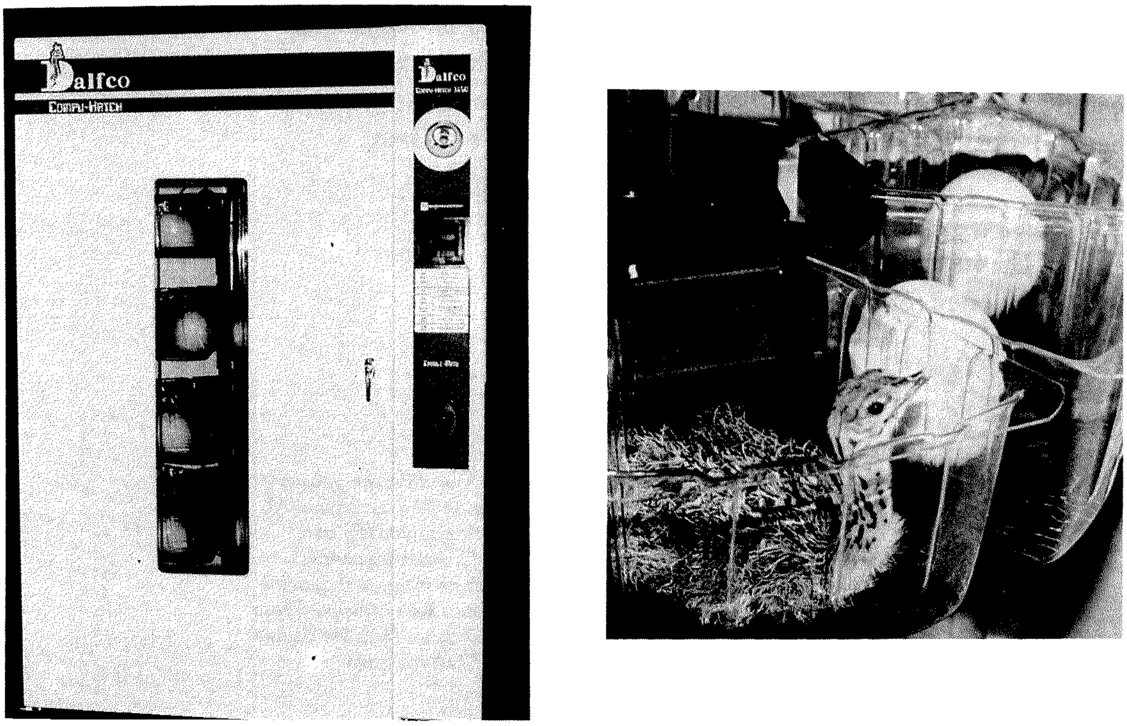
SEXING

Accurate sexing is a matter of great importance to breeders. Many ostrich breeders can attest to the time wasted in pairing birds of the same sex. In the majority of animals, a variety of differences are exhibited between males and females, but it is not always the case in birds. Ostriches exhibit their sex differences as adults, so early sexing becomes relevant when breeders want to sell young sexed birds. Several methods for sex determination in ostriches are described below.

Vent sexing

This is the conventional sexing method that requires physical examination of the sex organs. Details of the procedure involved in vent sexing have already been discussed in Chapter 2 in the section dealing with the reproductive system on p. 32. The accuracy and safety of this method depend greatly upon the skill and experience of the operator.

FIGURE 45
Eggs should be moved to the hatcher on day 38 of incubation (*courtesy of Dalfco Systems, Canada*)



Surgical sexing

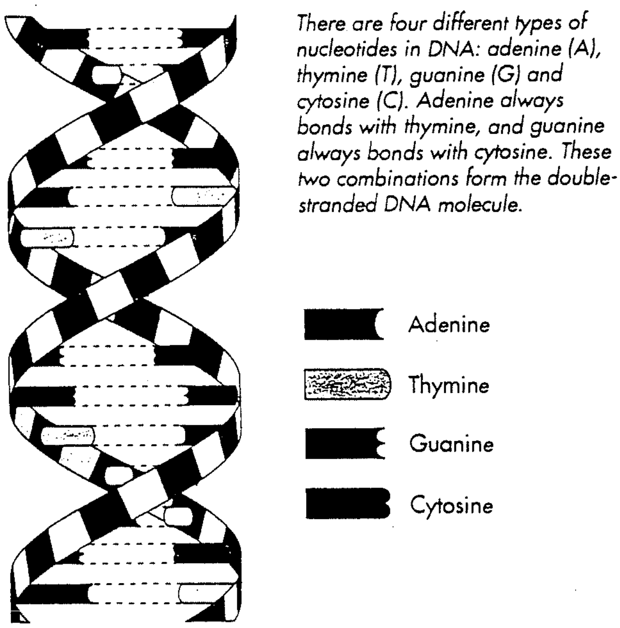
In this method an endoscope is inserted into the abdomen of the bird to see the gonads. Although the method has a very high degree of accuracy, it requires the use of anaesthesia and, therefore, carries some risk of anaesthetic death or injury. Furthermore, it is often difficult to sex young small birds surgically.

DNA sexing

DNA (deoxyribonucleic acid) is the genetic "blueprint" that determines every characteristic of a living organism (see Figure 46). Each ostrich has its own unique DNA or nucleotide sequence, which can never be altered, so that even though ostriches may look alike, no two birds will have an identical DNA. It is this that makes DNA analysis so valuable to breeders. In cells, DNA is located on structures called chromosomes. Sex chromosomes contain the genes that determine sex.

The sex of all birds (including the ostrich) is determined by the sex chromosomes. Male birds have two identical sex chromosomes called Z chromosomes (ZZ). Females have one Z chromosome and one W chromosome (ZW). When a male makes sperm, one of its Z chromosomes is carried into each sperm. When a female makes an ovum (egg), her contribution is different. If the Z chromosome is carried into the egg, the resulting embryo (ZZ) will develop into a male. If the W chromosome is carried into the egg, the resulting embryo (ZW) will develop into a female. The female chromosomes determine the sex of ostrich offspring, contrary to the case of humans.

FIGURE 46
DNA sequence (*Source*: Zoogen Inc., USA)



DNA sexing in ostriches requires a single drop of blood, from which a DNA sample is extracted. After undergoing several chemical processes, the DNA sequence is tagged with a radioactive label (called a "probe") which seeks out and attaches itself to DNA fragments from the sex chromosomes. The probe indicates whether the chromosomes are ZZ or ZW (i.e. whether the bird is a male or a female).

One of the best features of DNA sexing is its high accuracy (99 percent). The accuracy rate, however, depends on proper collection and labelling of blood samples. Breeders can take blood samples from birds of any age, even as young as day-old chicks, and obtain accurate results.

Chapter 6
Management of ostrich chicks

ARRIVAL AT THE FARM

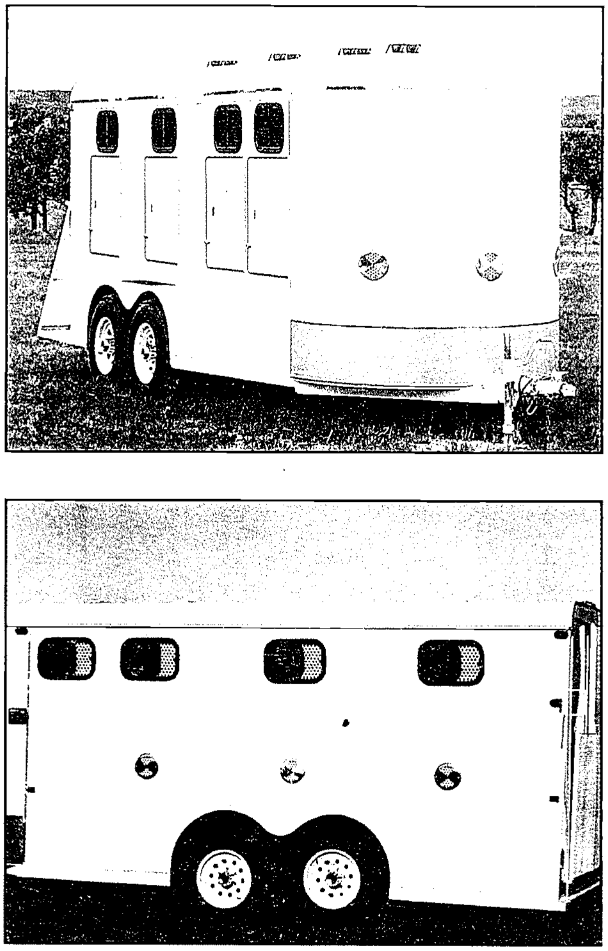
This section deals with the transport of ostriches of all ages and how to treat them on arrival at a farm. The transport of ostriches, whether by road or by air, is fairly stressful since the birds become disoriented in their unfamiliar surroundings. Transporting them during hot summers, with air temperatures reaching 55-60°C, is a major problem. However, there are a number of steps that can be followed in order to minimize stress during transport.

- A day before transporting the birds, add a vitamin/mineral mix to their drinking-water. This helps to reduce the stress normally caused during transport.
- Transport the birds at night when the air temperature is lowest. Darkness also makes the birds lie down and relax, which reduces any unnecessary injury caused by excessive movement as they try to keep their balance while standing.
- Reduce the numbers of birds to be transported. Although this may mean having to do two or even three trips, it is far better to have the birds running around on the farm than for them to be dead on arrival.
- Make sure that there is sufficient ventilation circulating around the birds or crates. Whatever is used to transport the birds, whether it be a horse trailer, horse box, van or a specifically designed vehicle (Figure 47), it should have exhaust fans to expel excessive heat and carbon dioxide and bring in fresh air.
- On arrival, make sure that the birds have plenty of fresh cool water to drink. Water medication during the initial three or four days would be beneficial to reduce any stress caused by the transport and also help the ostriches to settle down in their new environment. Provide enough shade for all the birds to use during the day for at least seven days after the move (and permanently if possible). Place the feed and water containers in the shade to encourage the birds to use the shade.
- Remember that if the birds have been imported, they will have been kept during the quarantine period in a controlled (or semi-controlled) environment with high standards of hygiene. These standards should be maintained on the farm.

Upon the arrival of the ostriches at the farm, it is best to keep them in their permanent accommodation for three to four days before allowing them access to paddocks. It is important to allow them time to familiarize themselves with their new environment.

Many ostrich farmers allow the ostriches, on arrival, to have access to large paddocks. This can prove fatal because the ostriches, having been imprisoned in a wooden box for a considerable length of time during transport, will injure themselves by running around frantically and possibly colliding with fences. Sadly, a considerable number of top adult breeding birds are lost every year in this manner.

FIGURE 47
Trailers built specifically for ostrich transport (*courtesy of Fredrick Trailers, USA*)



Ensure that the ostriches' new quarters and paddocks are free from large stones or any dangerous objects. Moving an ostrich (of any age) to a new environment or different enclosure can lead to the ostrich eating foreign materials indiscriminately with possible impaction of the digestive tract.

During the first few days when the ostriches are locked in their new quarters, if possible give the birds the same type of feed they are accustomed to. Over a period of seven days, gradually introduce the new feed. The easiest way to do this is to provide them with the two types of feeds after four days, and then begin to reduce the number of food troughs containing the old feed.

STOCKING RATES

During the vital first few weeks of their life, ostrich chicks should be housed indoors unless the air temperature is too high and it is difficult to maintain a constant temperature inside the brooding quarters.

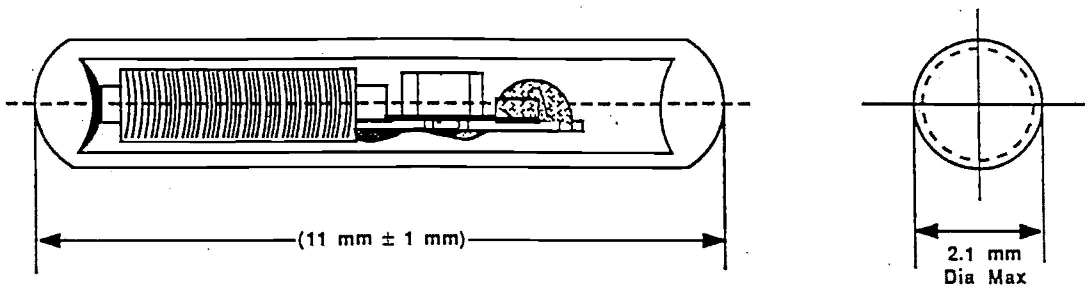
Overcrowding during the brooding and rearing stages can lead to slow growth rates, disease buildup, feather pecking and cannibalism. Space requirements for ostriches vary slightly according to type of accommodation. However, from a welfare point of view, 0.5 m^2 of floor space per bird during the first three weeks is generally recommended, increasing to 0.7 m^2 up to five weeks. From about five weeks of age (depending on weather conditions), the chicks should be allowed out for about one hour daily.

MICROCHIPPING

Microchipping uses microchip implants to identify the birds by number. Most people are familiar with the laser scanning of barcodes in supermarkets to identify goods in the checkout line. The electronic identification system provides essentially the same capability for the identification of birds. There are two basic differences between electronic identification and barcode technology: how the identification (ID) number is read and how it is stored. Electronic ID uses a common low power radio signal to read an ID number stored in a tiny electronic circuit rather than laser light to read a label. Electronic ID based on these radio signals is also referred to as "radio frequency identification" or RFID. Unlike light, these low-frequency radio waves can penetrate all solid objects except those made of metal. The use of electronic ID, therefore, allows a number to be stored inside the bird, where it is permanent and is not subject to being lost, altered, or torn like an external numbered tag.

The tiny electronic device used to store the electronic ID number is called a "transponder", which is made in various sizes - the smallest is about the size of a cooked grain of rice (see Figure 48). Transponders are easily injected into the bird, similar to the delivery of ordinary medication. The device remains inside the bird for life, and provides its unique ID number any time it is scanned by a compatible electronic ID reader. Transponders are passive devices; they do not carry batteries and remain inactive until energized by the low-power radio beam sent by the reading device. The transponder then sends the ID number as a radio signal back to the scanner, which decodes the number and displays it on a small screen similar to that of an electronic calculator. Since the transponders contain no battery there is nothing to wear out.

FIGURE 48
A diagram of a microchip, average weight 0.06 g (*Source*: Destron IDI Inc., USA)



Ostriches are best microchipped at one day old. The recommended implant site is the pipping muscle (the small muscle below the left ear that develops at hatching). One person holds the bird, while another extends the head gently holding it in the palm of one hand and implants with the free hand. If using prepacked microchips where each microchip comes inside a 12-gauge needle, the needle is loaded into the syringe implanter and implanting is carried out as described above. If using bulk microchips, each chip should be put into a sterilizing solution and again before implanting after inserting it inside the needle. Furthermore, the needle should be changed after about 15 implants since it becomes blunt.

If older birds are to be microchipped, the implant site will vary as the pipping muscle shrinks a few days after hatching. It is important to consider an alternative implant site that will not allow the migration or movement of the chip inside the bird. Any muscle will be a good implant site provided it does not affect the future value of the bird (e.g. at slaughter). The tail muscle is a good site to consider.

There is at present no legislation to enforce the use of microchips in ostriches. However, when importing birds, it is always "safer" (for obvious reasons) to insist on having them microchipped. There is a movement in the United States calling for all pen-raised ratites from approved farms to have microchip implants before shipment to that country. With the birds microchipped, an effective worldwide ostrich registry can be maintained.

BROODING ENVIRONMENT

Environmental stresses can have a devastating impact on the performance of ostrich chicks. Attention to factors such as temperature, humidity, proper nutrition, access to water, handling and disease prevention will minimize stress during the vital first few weeks of the ostrich's life.

It is generally recognized that the first few weeks of a chick's life are most critical to its survival, because chicks are extremely susceptible to stress. From a purely physiological standpoint, "stress" describes the magnitude of forces external to the bodily system that tend to displace that system from its resting or ground state, while "strain" is the internal displacement brought about as a result of the application of stress.

When the concept of stress is applied to animal production practices, it is considered to be a symptom resulting from exposing the chick to a hostile environment. Stress in ostrich chicks can be considered either a non-specific response to all environmental forces, or a specific symptom caused by a specific environmental force. The environment includes all the conditions to which a chick is subjected except those imposed by heredity. Consequently, the environment includes external factors (such as temperature, light, humidity, etc.) as well as internal factors (such as nutrition, disease-causing organisms, parasites, etc.) that act upon the chick.

When significant unfavourable changes occur in the environment, the chick's regulatory processes attempt to re-establish the state of equilibrium. Both the nervous and endocrine systems are involved in the chick's ability to adjust to environmental changes. Responses to the environment are generally initiated by the nervous system, which produces rapid short-term responses. These responses are continued by the endocrine system, which produces slower but longer lasting responses. Characteristically, though, development of the nervous and the endocrine systems in the ostrich chick is not complete until five to six weeks of age. It is for this reason that stress stimuli to the growing chick such as temperature extremes, overcrowding, poor nutrition, injury and disease agents often result in lower disease resistance, poor growth and, in many cases, death.

Brooding temperature

Temperature is extremely important for all domestic birds, but is particularly so for day-old chicks, which are exposed to temperature stresses even before they are placed in the brooder/grower house. For instance, temperature variations in the hatchery holding room and during transport will often severely stress the young chicks.

The temperature at which the ostrich chick emerges from the egg is between 35 and 36°C. It is logical therefore that the brooding temperature, during the first two days, should be as close to 35°C as possible to avoid too much of a change in the chick's first environmental experience.

Chicks should be started at 33 to 34°C and the temperature should be lowered gradually (either daily or weekly) until an ambient temperature of 21-23°C is reached at about four weeks of age.

One way to enhance the chick's own body temperature is to get it to eat as soon as it is placed in the house, particularly if low environmental temperatures are a problem. By contrast, when environmental temperatures are high, day-old ostrich chicks will not eat since the process of digestion produces a considerable amount of heat.

High temperatures induce the chick to pant in an attempt to prevent its body temperature rising. Panting increases evaporative cooling through the moist membranes of the respiratory tract. This process increases breathing rate concomitant with the loss of moisture from the body. To compensate for this loss, chicks drink more water to avoid dehydration. However, as complete temperature regulation (thermoregulation) in ostriches is not attained until much later in life, the young chick is unable to make the necessary intricate adjustments.

Recording of inside and outside temperatures helps to evaluate the environmental control system being used. A knowledge of the high and low fluctuations of the daily temperature provides further valuable information on how the building is functioning in terms of insulation and how the brooding and/or ventilation system is operating to provide a uniform environment for the growing birds.

Relative humidity

Relative humidity (the amount of water carried in the air) affects panting rate. The higher the humidity, the faster the respiration. Since the air is moist, it cannot absorb much moisture from the lungs of a panting bird; the chick will pant faster but to no avail. When the bird is exposed to both high humidity and high temperature, it is unable to pant fast enough to dissipate its body heat. Death will almost certainly occur under these conditions.

Drinking-water

The daily water consumption of chicks is extremely important. Recent research shows that young ostrich chicks consume more water per unit of body weight than older ostriches. This affects the efficiency of water medication prior to four weeks of age. To minimize the possibility of dehydration, the chicks should be provided with fresh clean water at least twice daily. All water containers should be routinely cleaned and if possible disinfected weekly.

Ostrich chicks are initially unable to recognize water, but they like to peck at flat shiny surfaces. Furthermore, plain water is not the most effective stimulus for pecking, whereas coloured water is a supernormal stimulus. It is therefore beneficial to put large shiny objects (such as large metal spoons) inside the water containers or to add yellow or green food dye to the water. As soon as the chicks' beaks are immersed in the water, they learn how to drink.

Drinking-water temperature is also important. Birds will normally drink cold water but tend to avoid warm water or water above 45°C. If the water feels warmer than hand temperature then it ought be changed.

A drop in water consumption is often the first indication that birds have problems. The production of white urine can be indicative of water deprivation. One of the ostrich's remarkable adaptations to a shortage of drinking-water is to concentrate its urine. Its normally copious colourless urine changes to a thick white excretion after two days of dehydration; no fluid is excreted at all after three to four days.

Sugar and vitamin/mineral packs may be added to the water for the first week. About 0.25 kg of sugar should be added to every 4.5 litres of water and the packs should be used according to the manufacturer's directions. This water treatment is particularly important if chicks have been transported over a long distance and are dehydrated.

Measuring water consumption is also important. Although feed and water consumption are closely related, water consumption may fall before feed consumption in the event of a disease outbreak, and careful daily records can provide the producer with an early lead in identifying and correcting a problem. If water is supplied through automatic water drinkers, water meters should be read at the same time each day and any deviation from one day to the next should be immediately investigated.

Feed

Lack of feed or incorrect nutrition are environmental stresses that have a significant impact on the chick's development and survival. Care should be taken to ensure that feed is delivered well in advance of the chick's hatching. Although the yolk sac continues to supply the chick with necessary nutrients after hatching, some feed should be available at all times, at least for the first week. Feed should be dispensed into wide flat containers, but not so wide that chicks are unable to get out of them. As a general rule, they should not be much wider than the width of the chick at any age. After the first week, food restriction programmes can be applied if desired.

Ostriches are greedy and continue to eat until they gorge themselves, with the result that food tends to pack in the stomach. After the first week, it is advisable to offer limited amounts of fresh greens and dry food more frequently (two or three times a day) rather than in one lot.

Newly hatched ostrich chicks do not have an inherent ability to recognize food but they exhibit a strong tendency to peck at small particles. As time passes, and as a consequence of consuming different items, they gradually learn to distinguish between nutritious and non-nutritious particles and hence pecking at food increases. Ostrich feeding time is considered a social activity, and the birds tend to feed as a group whenever possible.

Under natural conditions, the chicks follow their mother and whenever and wherever she stops to peck at food items, they will gather round and join in the pecking activity. This social behaviour can be put to good use in stimulating the feeding of young ostrich chicks. An effective way of encouraging newly hatched ostriches to eat is to put them with a slightly older chick that is already feeding well, or with a broiler chicken. If the latter is used, make sure that it is not vaccinated and is debeaked so that it cannot peck at the chicks' heads and cause them harm.

Feed should be kept away from direct heat to prevent it from drying out and from the deactivation of the fat-soluble vitamins A, D, E and K.

Ostriches need grit to aid the gizzard (the macular stomach) in grinding the feed. In no way, however, should grit be offered ad lib. Furthermore, it is important to start with grit 1-2 mm in diameter and increase the grit size as the birds get older. Grit should be selected with care; it should be insoluble, non-friable (i.e. not easily fractured and broken into small pieces), have no sharp edges and be hard enough to withstand the pressures of the gizzard.

Light

During the first few days of the chick's life, continuous or near continuous light should be provided. The ability to see its surroundings will help the chick to learn quickly where to find food and water. Once it has learned how to eat and drink, a specific light programme or pattern can be implemented, depending on the purpose of production.

The lighting pattern is one of the most important components of any production programme. It should be determined in advance and checked carefully to ensure that it is being followed. This means that the time clock should be checked on a weekly basis to ensure that the lights are switched on and off at predetermined times. Lighting intensity is a different aspect of ostrich management and should also be carefully controlled. A simple light meter will provide valuable information and levels should be checked periodically to ensure that light bulbs are adequately maintained.

Handling

Many producers weigh chicks at regular intervals to determine whether they are growing at the right rate. Since handling is stressful to ostrich chicks and lowers their immunity system, their height can be used as a guide to their growth instead. Wooden rulers strategically placed on the walls will allow the keeper to monitor the birds without having to handle them. Although sexing can also be successfully performed from about three weeks of age, the need to do this is not so important as keeping the birds alive and in good condition. Sexing at three weeks or at ten weeks will not change the sex ratio in a flock.

In short, ostrich chicks should not be handled unless it is absolutely necessary to do so, as, for example, in the administration of medicines.

Diseases

Active disease prevention must take place in the breeder flocks, at the hatchery and on the farm. This cannot be achieved without a conscientious programme throughout the different production units.

One of the major causes of early mortality in ostrich chicks is yolk sac infection, which is caused by several different bacteria as a result of poor hygiene in the breeder flocks and in the hatchery.

In the wild, ostrich chicks, like most chicks, hatch from the eggs with limited immunity derived from the mother through the yolk. They acquire further immunity through the ingestion of their parents' fresh faeces, which contain antibodies and some vitamins of the B group. This process provides protection against the bacteria present in the environment of the parents. By raising the chicks separately from the parents, this source of parental immunity is removed. In such cases, the administration of a broad spectrum antibiotic in the drinking-water would help to reduce chick mortality.

Furthermore, continual removal of the chicks' own faeces reduces the spread of infection to healthy chicks.

Ammonia concentration

The high concentration of ammonia is a serious problem that most ostrich rearers fail to recognize and appreciate. Ammonia buildup occurs as a result of insufficient ventilation in the house and the problem is more pronounced in cold climates. To improve inside temperatures, producers are inclined to cut down the ventilation rate. This means that ammonia and other obnoxious gases cannot be efficiently removed and oxygen-rich air cannot get in. When the concentration of ammonia in the air is higher than 20 ppm (parts per million), it causes irritation in the mucous membranes of the respiratory tract and sinuses, resulting in increased incidence of respiratory diseases and high chick mortality. Ammonia levels can be easily measured and in no circumstances should they be allowed to exceed 20 ppm. The expulsion of excessive ammonia from the rearing quarters through exhaust fans is an established way to lower mortality and reduce disease incidence.

Exercise

Ostrich chicks need plenty of exercise from a very young age, the earlier the better. Exercise helps to reduce impaction of the digestive tract by increasing its motility and also enhances blood circulation and promotes correct muscle and bone formation and development. The use of long runs attached to the chicks' quarters is perhaps the most widely used method of exercise (see Chapter 3 - Design of ostrich facilities, p. 40). One of the most ingenious methods developed in Namibia is to use a "chick mobile". Here the chicks are grouped (20-30 per group) into a three-sided wooden partition mounted on wheels. Once the chicks are in, the gate is closed and the chick mobile is pushed by two workers for half an hour daily.

Chapter 7
Nutrition of the ostrich

BASIC NUTRITIONAL CONCEPTS

Feeding has three main purposes: to maintain life, to ensure proper growth and to allow for maximum egg production and reproduction of breeding birds. The feed consumed by ostriches must contain the following essential classes of nutrients to satisfy their needs:

- Water
- Protein
- Carbohydrates
- Lipids
- Minerals
- Vitamins

Apart from water, all the other classes of nutrients include many different compounds. Nutrients must be supplied in adequate quantities in the feed for highest growth and best possible utilization. If any nutrient is lacking, it will quickly become a limiting factor for the bird, for a lack of one essential factor cannot be remedied by an excess of another. There are, in fact, many cases where an excess of a nutrient causes a detrimental imbalance.

Inadequately fed ostriches will rapidly reflect deficiencies through a decline in growth rate, production of eggs, fertility and general performance. The bird will then normally exhibit signs of classical nutritional deficiency diseases (see Chapter 9). When a dietary deficiency is marginal, symptoms will first appear in the most rapidly growing or high egg-producing birds because their nutritional requirements normally exceed those of the average bird.

Water

The newly hatched ostrich chick is about 75-80 percent water. As it ages, this percentage changes but the bird's need for water remains. No other nutrient is as important as water for its many vital roles in the body, particularly in metabolism, thermoregulation and transfer of other nutrients and chemicals in the blood. Without ample amounts of water, production performance will suffer. All feed ingredients contain some water, but this may not be adequate to meet the needs of the bird. Although water is one of the least expensive ingredients available, it is frequently supplied in inadequate quantities. It should be provided continuously and be easily accessible to all birds. It should be free of excess minerals and salts, free of high bacterial contamination, low in nitrates, and generally of a quality suitable for human consumption. Furthermore, water troughs must be constructed so that minimal contamination can occur from birds' faeces, litter and other foreign materials.

The water requirement of ostrich chicks changes with age and quantity and quality of feed. As a general rule, however, water should be provided at three times the amount of feed consumed, at all ages.

Protein

There are many different proteins, but all are composed chiefly of comparatively simple compounds known as alpha-amino acids, or more simply as amino acids. Amino acids are the "building blocks" for tissue growth. Protein quality is generally based on two major factors: amino-acid composition of the foodstuff and the availability of these amino acids from the foodstuff through digestion in the gut of the bird. Some of these amino acids are called "essential", because ostriches are monogastric (single-stomach animals) and are therefore unable to manufacture them in the body. For this reason, it is important that they should be supplied in the diet at the right concentrations.

Foodstuffs differ quantitatively and qualitatively in their amino-acid composition. In order to supply all the necessary amino acids in the ostrich feed, it is vital that high protein feed ingredients should be obtained from both plant and animal sources. Although plant materials are cheaper protein sources than animal products, a portion of the protein should be provided from animal products to ensure adequate levels of those amino acids that are not adequately supplied by plant materials, such as methionine and lysine.

Major sources of animal protein are meat and blood meals (by-products of slaughterhouses), fishmeals (by-products of certain fish) and milk products. Major sources of plant protein are soybean, peanut, sesame, cottonseed and sunflower-seed meal (all are by-products of the oil industry).

Energy

Energy is considered to be the most important requirement from the standpoint of total cost and quantity of ostrich feed. As a general rule, the ostrich eats to satisfy its energy requirements. To that end, the energy content of the diet determines, within limits, the quantity of feed consumed, including the protein, minerals and vitamins contained in the feed. Foodstuffs high in carbohydrate constitute the major volume of ostrich diets. Carbohydrates are the primary source of energy for the bird. Major carbohydrate sources are grains, primarily maize, wheat, barley and oats.

Lipids (fats and oils) are placed in a single category of nutrients since they are utilized for a specific purpose. They have high energy values, but should only be used at relatively low levels since the feed will begin to lose its optimum flow characteristics at about 5 percent added level. Animal tallow is a major fat source, although vegetable oils are also commonly used. Lipids are added to diets to reduce dust in the feed and improve palatability.

Minerals and vitamins

Minerals are inorganic chemical elements that have numerous functions in the body. Compounds of these elements are found in all tissues and, in the absence of certain minerals or vitamins, the various organs and tissues of the bird are unable to perform their functions with the result that good health, growth, and reproduction cannot be maintained.

Although most minerals are important for the ostrich, calcium and phosphorus are of particular importance since they are used in bone and eggshell formation. Vitamins are classified as fat soluble (A, D, E and K) and water soluble (B-complex and C).

Fibre

Fibre can be found in nearly all sources of animal and plant products except fats and oils. It is necessary to provide a certain amount of bulk in the diet for efficient digestion and physical consistency and movement of food materials through the digestive tract. Unlike ruminants, the digestive system of the ostrich is not designed to handle large amounts of fibre.

There are many sources of fibre that can be added to the diet, such as grain hulls, wood shavings, corn cobs and other high-cellulose products. Chopped alfalfa can also be added. Dietary fibre is particularly effective in controlling cannibalism and feather pecking among imported ostriches in quarantine confinement.

Grit

The gizzard grinds feed by crushing it and tearing it apart. Grit aids the gizzard to grind the feed by providing hard, smooth surfaces between which the particles of feed may be crushed. Although the gizzard is capable of grinding the feed without the aid of grit much less of the feed is crushed and digested. Because of the manner in which grit aids the gizzard, grit with sharp edges is of little value until the sharp corners and edges have been worn away, and smooth surfaces have been provided between which the particles of feed can be crushed. Pressures of up to several hundred kilograms per square centimetre are developed by the muscular contractions of the gizzard, which has enormous crushing power. Careful consideration should be given, therefore, to the selection of grit to be fed to ostriches; its physical properties are especially important (see Chapter 6 - Feed, p. 93 for a more thorough discussion of suitable material to be used as grit).

To sum up, any material used as grit should be insoluble, non-friable and hard enough to withstand the pressures of the gizzard. Furthermore, it is important to remember that the size of the grit used should be increased as the birds get older. As a rough guide, the size of the grit should be about the size of the ostrich's big toenail.

NUTRITIONAL REQUIREMENTS OF GROWING OSTRICHES

At present, ostriches are reared "as hatched"; males and females are not reared separately. When birds are raised solely for meat and leather production, males may have to be raised separately because they grow faster, require higher protein diets and are more efficient as feed converters for a longer period than the females. The latter reach the stage of diminishing returns earlier and thus have to be marketed at lower body weights than the males. Research on the nutritional requirements of male and female ostriches points to the necessity of raising them separately.

Ostriches, like all birds, are monogastric. However, as stated in Chapter 2, the ostrich has some interesting anatomical features. It has no crop; the first part of the gullet (oesophagus) is like a pouch where food accumulates until the bird lifts its head to swallow. The last part of the gullet widens to become the glandular stomach (proventriculus) which joins the muscular stomach (gizzard).

From one day to three months

The ostrich chick can feed on the remainder of the yolk sac for the first seven to ten days of its life. After hatching, therefore, the chick's need for water is greater than its immediate need for food. For this reason it may be useful to withhold feed for two to three days after hatching, first, to ensure that the chicks find water and, second, to give them time to utilize their yolk sacs quickly, thus preventing them from being retained.

It is important to ensure that the birds are drinking. If they are not, the brooder light intensity may need to be increased or the temperature adjusted. The production of white urine may be indicative of water deprivation in ostriches; the normally copious colourless urine changes to a thick white excretion after two days of dehydration and no urine is excreted at all after three days. Water troughs for ostrich chicks should be the same width as the ostrich chicks at any age. It is recommended that chicks be initially offered food in crumb form and, if floor brooding is used, that crumbs are spread on paper or egg cartons for the first week, after which feed troughs can be introduced.

Some important points need to be considered when formulating a diet for ostrich chicks. Whether the chicks are raised for meat or for breeding, their initial growth should be controlled to avoid problems normally associated with fast growth, e.g. leg and skeletal disorders. If the chicks are allowed to grow quickly, this will undoubtedly lead to a higher percentage of leg abnormalities because of the fast increasing extra load on the legs. Some form of feed restriction is therefore recommended during the first three to four months of the chicks' life; the quantitative and qualitative methods of feed restriction are perhaps the most appropriate.

With quantitative feed restriction, the chicks are offered a predetermined amount of food per day, either in one lot or divided into two to three lots. The disadvantage of using this method is that some chicks (particularly the stronger, more aggressive ones) will consume more food than the others. This in turn will create a flock of poor uniformity.

With the qualitative method of food restriction, the chicks are offered an ad lib diet low in certain nutrients. The restriction here is in the quantity of certain nutrients in the feed and not the quantity of feed offered. Caution should be exercised in order to avoid limiting those nutrients that are vital for proportional growth (the growth of the different parts of the body at the correct rate). Limiting the energy content of feed to values between 9 and 10 MJ ME/kg (calculated on the basis of poultry feed nutrient value) is normally sufficient to control body growth.

Fibre content in the diet should also be considered. Although ostriches are able to digest more fibre than other domestic birds (because of hind gut fermentation), they are only able to do so after reaching a certain age. From hatching up to about two months of age, ostrich digestibility of neutral detergent fibre is only 6-15 percent. This increases after four months of age to reach 58 percent. Accordingly, it is important not to feed diets containing more than 5 percent fibre during the vital first few weeks of the chick's life. Similarly, the ability of ostrich chicks to digest fat early in life is quite low, hence dietary fat content should not be higher than 5 percent.

From three months to one year

The birds' nutritional requirements change as they become older. Emphasis should be placed on increasing both the energy and fibre contents and reducing the crude protein value of the feed. The dietary fibre should be allowed to increase at four to five months of age to around 10-11 percent. This is also important for correct feather development. Analogously, the calorific value of the feed should be increased to around 10-10.5 MJ ME/kg. Crude protein content should be reduced gradually to about 18-20 percent.

A balance between calcium and available phosphorus concentrations should be maintained at 1.8-2:1. Feeding should be ad lib.

NUTRITIONAL REQUIREMENTS OF BREEDING OSTRICHES

Ostriches reach approximately 90-95 percent of their full weight at around one year old. With attainment of full muscular and skeletal growth, there is very little increase in metabolic size after that age. All major metabolic changes in the body are mainly geared towards the development of the sexual organs: the ovary and oviduct in the female, and the testes in the male.

From one year to breeding

Maintaining the birds in prime condition is of paramount importance. Obesity is one of the major problems encountered between one year of age and the commencement of breeding. Likewise, starvation or underfeeding delays sexual maturation and leads to poor performance during breeding.

A combination of both the quantitative and qualitative feed restriction methods is most appropriate. A balanced diet with all vitamins and minerals but low in protein and energy should be adopted. Dietary fibre could be increased up to 15 percent. Birds should be offered 1.5 kg of the diet daily. During cold weather spells, the addition of a high-energy rich source (e.g. full-fat soybean) is recommended.

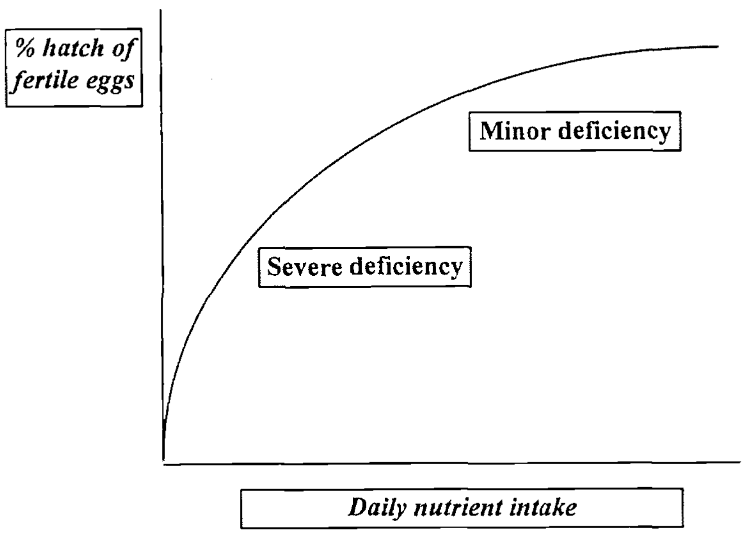
The above feeding regime should also be applied between the breeding seasons. Separate feeding of males and females is preferable when they are not breeding.

During breeding

From the age of 18 months, birds should be offered a breeder ration, which should ideally be relatively high in energy and protein and low in fibre. Birds preparing for the breeding season or already in breeding require higher energy levels to sustain their production (whether eggs or sperm). Although some dietary fibre can be converted into energy by the ostrich, the birds require a more readily available source of energy during breeding.

Moreover, ostrich eggs contain about 20 percent shell, of which calcium is the main constituent. Consequently, it is indispensable for calcium and available phosphorus levels to be increased at the onset of breeding or at 18 months of age to at least 40 and 4.2 g/kg respectively (7.5 g total phosphorus). Failure to do this may prevent egg laying altogether or result in poor rates of egg productivity, hatchability of fertile eggs and increased production of soft-shell or shell-less eggs (Figure 49).

FIGURE 49
Representation of the flock input/output response curve



Chapter 8
Ostrich products

Ostrich farms are currently considered to be among the most profitable agricultural projects. They are often referred to as "the farms of the future" because of the large variety of products involved and hence the high profit potential. Ostriches are raised commercially for their meat, hide and feathers.

OSTRICH MEAT

Ostriches produce red meat that is similar in taste and texture to veal and beef (depending on age at slaughter). It is high in protein and yet low in fat. The United States Department of Agriculture has recently published the following comparison of the nutritive values of chicken, beef and ostrich meat (Table 10).

TABLE 10
The nutritive value of ostrich meat

- Per 100 g	Chicken	Beef	Ostrich
Fat	3.6 g	16.3 g	2.0 g
Cholesterol	85 mg	84 mg	58 mg
Energy	185 kcal	256 kcal	114 kcal
Protein	21.4	20.0 g	21.9 g
Calcium	13.0 mg	9.0 mg	5.2 mg

The study indicates quite clearly that ostrich meat is far better than other types of meat from a health point of view, because it contains much less fat and cholesterol. With recent increased consumer awareness of the problems of high cholesterol levels in the blood and their possible association with the increased incidence of heart attacks and cardiovascular problems, the demand for ostrich meat on the international market has grown and is continuing to do so. The latest statistics show that current ostrich meat production is not enough to fulfil the increasing demand in Europe, America and Japan. It is expected that ostrich meat may gradually replace traditional types of meat during the next decade.

Slaughter of ostriches

One of the most important elements of commercial ostrich operations is the abattoir. The ostrich abattoir should be built to high standards and operated in line with the strictest food hygiene regulations. This will not only make its operation more efficient but will also increase the number and range of markets available to the operator. Because of the ostrich's particular characteristics, facilities designed for slaughtering other livestock are unsuitable. Purpose-built abattoirs are needed, incorporating or featuring a holding area and separate areas for killing, plucking, skinning, evisceration, deboning, chilling, packing, freezing and dispatch. The ostrich abattoir should be designed on a modular basis so that it can be easily expanded as market demands increase.

FIGURE 50
After plucking and skinning, the carcass is hung before deboning

Birds are ready for slaughter between 10 and 14 months of age (depending on management and growth rate). Once they have been gathered in holding pens, they are guided into the slaughter box, one bird at a time. Preferably, birds should be guided by their handler into the box as this will help them stay to stay calm and docile. The slaughter box should only be large enough to contain one ostrich. Strips connected to a chain on a mechanical pulley are placed around each leg and the bird is stunned with an electric stunner (similar to that used for sheep). Before the bird falls to the ground, it is pulled up by the chains around the legs and hung upside down. It is then moved to the next person in line where the head is severed and the blood allowed to drain. It is plucked and skinned after which the carcass is removed and normally hung by the wings and eviscerated (Figure 50). The eviscerated carcass is allowed to cool in the chilling area at 1°C. The chilling period varies in length between countries and operators from only a few hours to a full 24 hours. Deboning is carried out (Figure 51) and the meat is sorted into different cuts, normally vacuum packed in 2-kg packs and either dispatched fresh (with a shelf life of approximately three weeks) or moved to the freezing area for storage at a temperature of -20°C.

Meat yield

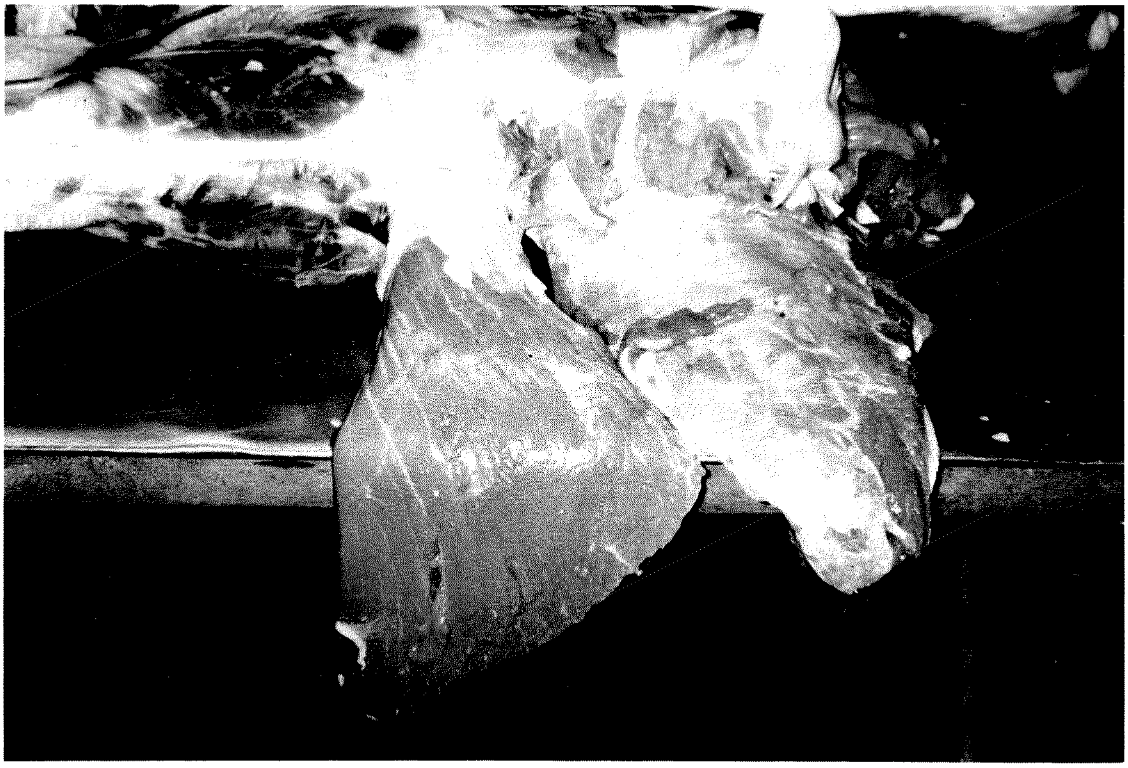
Meat yield varies according to age at slaughter. A 12-month-old ostrich weighing 100 kg live weight will yield a carcass weight of 60 kg (a dressing-out percentage of 60 percent). Depending on age, sex, and management standards, the dressing-out percentage ranges from 56 to 64 percent. Males yield approximately 1.5 percent more than females. Table 11 gives a breakdown of the remaining 36-44 percent.

TABLE 11
Non-carcass components of ostriches

Component	% live weight
Blood	6-7
Head	0.8-1.0
Feet (from hock down)	3-3.5
Hide	7-8
Wings	1.2-1.5
Offal (liver, kidneys and heart)	3-4
Viscera (digestive tract, lungs, etc.),	15-19

On average the liver represents 1.6 percent, while the heart and both kidneys are 1.1 and 0.6 percent respectively of live weight. The legs are about 70-74 percent of carcass weight, while the neck represents 3-4 percent.

FIGURE 51
Deboning of the carcass is followed by sorting of the meat into different cuts



Carcass lean meat is around 60 percent of the dressed carcass weight (ranging from 55 to 65 percent). When slaughtered at the same age, males provide a higher lean percentage than females. This is primarily because of the lower total fat content (up to 5 percent) in male carcasses. As a rough approximation, an ostrich carcass contains 60 percent lean meat, 25 percent bone and 15 percent fat. As stated earlier, these percentages vary greatly with age, sex and management practices. For example, the bones become heavier as the bird gets older. Similarly, the deposition of fat increases with age.

For marketing purposes, ostrich meat is at present broadly divided into two categories: prime cuts (steak and fillet) and trimmings or offcuts; with a ratio of 1.5:1, respectively. Hence, a bird weighing 100 kg will yield approximately 21 kg of prime cuts and 14 kg of offcuts. The neck is usually sold separately and cooked like oxtail.

Ostrich meat products

A special feature of ostrich meat is that it is high in protein and low in fat content. This makes it extremely suitable for further processing into meat products, either on its own or combined with other types of meat. Ostrich meat is currently marketed in a variety of ways: as pastrami, frankfurters, ham, pâté, bacon, fillet steaks and smoked sun-dried biltong (or Jerky), in addition to fresh meat cubes and stir-frys.

Dried sausages and biltong are the traditional delicacies of ostrich meat and are marketed throughout the southern African countries and North America.

OSTRICH SKIN

Ostrich skin is considered to be one of the most luxurious leathers. Some even place it on the same quality level as crocodile and snake skin. Ostrich leather is thick and durable but extremely soft and can be manufactured into a variety of products e.g. shoes, bags, purses and jackets.

Maximizing the skin value is of obvious importance to ostrich producers. Extreme care is required with all stages of ostrich skin preparation: skinning, curing, grading and packing. The final value of an ostrich skin can be greatly reduced by poor or unprofessional preparation.

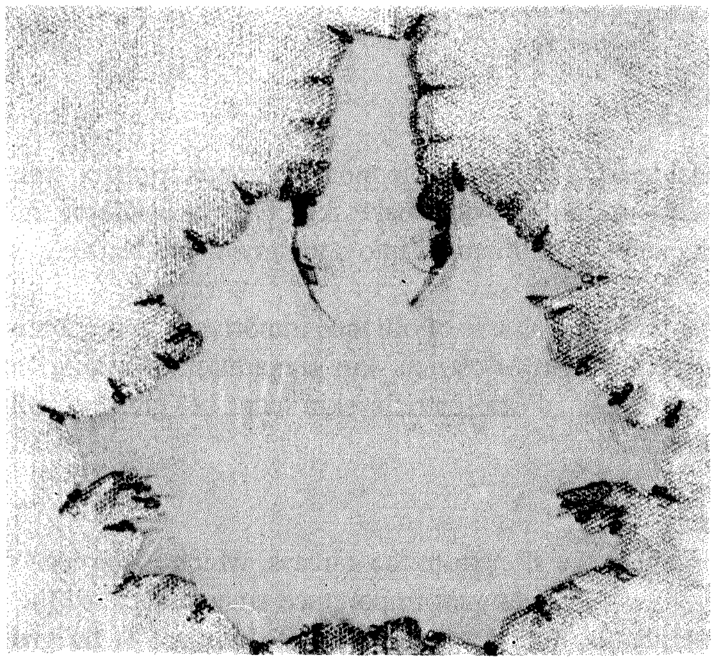
Skinning (flaying)

The method of removing the skin from the carcass, which is termed "flaying" but better known as "skinning", is of paramount importance since it dictates the final shape of the skin. The characteristics of the pattern areas on the skin are of far greater importance in the market place than is generally recognized. The way in which the first cuts or "cutting lines" are made on the carcass determines the value of the finished leather.

The aim of following specific cutting lines is first to maximize the quill areas on the skin and, second, to maximize the total area of skin produced.

Cutting lines. With the bird hung, its head down and abdomen facing the operator, a central straight abdominal line is cut from the cloaca through the middle of the abdomen and the underside of the neck to the point where the base of the head joins the neck. The head is removed (unless it has already been removed at slaughter) by cutting all the way round the neck. For the cutting lines of the wings, an incision is made at the tip of the wing and then a straight line is cut following the centre of the underside of the wing until it joins the central abdominal line. For the cutting lines of the legs, a complete incision is first made around the ankle (hock) joint separating the skin above and below it; a cut is then made following a straight line on the inside of the leg until it joins the central abdominal line. (It should be recorded here that the ankle joint is often mistakenly called the knee joint.) The skin can now be carefully separated from the flesh. The use of skinning or flaying knives should be reduced only to those parts where it is not possible to pull the skin gently from the carcass. Cuts and marks on the skin, caused by knives, can be easily inflicted, causing a significant drop in market value. Figure 52 shows the shape of a whole ostrich hide.

FIGURE 52
The shape of a whole ostrich hide



A small air compressor can be used, before starting the cutting line, to facilitate the separation of skin from flesh. In this particular case, a small incision is made at the ankle joint and a compressor hose is inserted through the hole under the skin for 10-15 cm in the direction of the abdomen. A cord is tied around the neck at the base of the head, and the incision is closed tightly at the ankle with one hand. This creates an airtight effect as the pressure builds up slowly. To avoid any damage to the skin, the pressure should not be allowed to exceed 10 kg/cm^2. The skin can be observed "bubbling" away from the carcass. It can be freed by gentle tapping. Once all the skin is free, the cutting lines described above should be followed.

To remove the skin around the tarsometatarsus, a straight line is cut on the backside extending down the rear footpad to the nail and a cut is made around the toe where the nail emerges; the skin is then carefully freed. This renders a separate piece of skin containing the oblong scales.

Curing

After removing the whole skin, all remaining fat, flesh, etc., should be scraped off with blunt knives or scrapers. This should preferably be done on scrubbing boards. Failure to remove all the fat and flesh can reduce the efficiency of curing and interfere with the tanning process. The presence of grease stains on the finished leather is indicative of poor or unprofessional preparation of skin. The hide should also be rinsed thoroughly to remove any blood spots or clots before curing. Furthermore, since the skins are subject to rapid decay if left exposed to the air before curing, lengthy exposure should be avoided as it is extremely difficult to rectify the damage caused by decomposition. Skins should, however, be allowed to cool for 15-20 minutes off the ground in a shady clean place.

The main reason for curing a skin is to preserve its fine structure until it is restored to its original state before tanning. Curing or preserving the skin reduces its moisture content to approximately 15 percent. This is normally achieved by saturation with salt, which also stops the growth of bacteria. However, if the skin is too dry, it will become brittle and may crack and will also be difficult to rehydrate during tanning.

Wet salting is the curing method used for ostrich skins. This method requires a well-ventilated curing shed with a well-drained impervious floor, upon which the skins can be salted and stacked. Non-iodized coarse cooking or rock salt (sodium chloride) is used in the ratio of 2-2.5 kg salt for every 1 kg freshly flayed skin. Skins are laid flat (with the flesh side upwards) on a wooden slatted platform at least 6 cm from the floor. They are then covered with clean salt. They may also be stacked in an overlapping fashion, with 2-3 cm between each layer (always with the flesh side upwards). Curing takes between 60 and 72 hours, after which the skins are graded and refrigerated until tanning.

Careful attention should be given to hygiene during skinning, curing and storage. Halophillic bacteria, which grow in the presence of salt, can be present on wet salted skins. During growth, some of these bacteria produce pigments or coloured spots, which may affect the final quality of the skin. These bacteria are chromogenic and are manifested by the development of red or orange colour patches on the flesh side of the skin. Such patches are known as "red heat" and frequently appear on the skin when curing extends beyond 72 hours, especially in hot or humid weather conditions. To avoid the development of red heat, hygiene is extremely important, storage time at ambient temperature should be kept to a minimum, and the skin treated with antiseptic chemicals.

Grading

A number of features are considered in assessing wet salted skins. These features ultimately reflect the suitability of each skin for manufacture into top quality finished products. The number of grades varies slightly between countries but generally ranges from four to five grades, the last grade being rejects. Features of wet salted skins to be noted may be summarized as follows:

- Effectiveness and quality of skinning or flaying.
- The shape of the skin. A complete full-size skin includes legs, wings and neck. The shape is greatly affected by the type of cutting or opening lines followed and the quality of skin separation from the carcass.

- Presence and extent of faults or defects, e.g. scars, cuts, holes, damaged feather follicles and scratches.
- Quality of curing, including skin preparation before curing.

Accordingly, skins are selected as first, second, third and sometimes fourth grades, and rejects. The top quality, most valuable first-grade skins are fresh, well cured and full size with correct cutting lines; they have no flesh, fat, or blood clots (on the underside) and no damaged feather follicles, cuts, holes, red-heat patches, or any other defects. According to the number and position of defects, the skins are then graded from seconds down to rejects. In current monetary terms, there is a difference of US$5 per square foot (0.09 m^2) between each grade (a drop in market value for each skin of approximately US$90 for each downgrading).

Packing and storage

Once graded, the skins can be packed and stored until sent for tanning and manufacture. They are either folded to approximately A4 size (29.7 x 21 cm), or rolled along the width. Leg or tarsometatarsus pieces are normally folded from the ankle joint. Skins should be stored in refrigerated rooms until they are sent to the tannery.

Tanning of ostrich leather is a unique challenge because the ostrich has large fat reserves that occur in horizontal fibrous layers beneath the quill-bearing areas of the skin. Moreover, processing normally entails considerable labour because of the irregular shape of the skins and the deep-seated quill roots.

Ostrich leather products

Highly distinctive grain patterns occur on ostrich leather. About 40 percent of the leather is characterized by quill marks, while the remaining 60 percent has striations similar to those on the palm of the human hand. Skilful designers combine both patterns in ostrich-leather articles.

Depending on the correct choice of skins, body leather is generally suitable for handbags, belts, travel goods, briefcases, shoes, small leather goods, office desk furnishings, upholstery and jackets. No other exotic leather can boast such a wide variety of applications.

Body leather is normally finished in two ways:

- semi-matt (classic) - fully dyed leather with a semi-analine finish
- glossy (saddle) - fully dyed leather with full analine finish

Leg skins are normally produced with a glazed, high-gloss finish. A small percentage is produced with matt finish. See Figure 53 for examples of finished ostrich leather products.

FIGURE 53
Examples of ostrich leather products

FEATHERS

Ostrich feathers are almost certainly the best known of all ostrich products. Their qualities are quite unique. Even the latest technology has been unable to simulate the natural flowing beauty of ostrich plumes, and no other fibre has ever been created with the special quality of generating static electricity that makes ostrich feathers such efficient cleaning tools.

Ostrich feathers can be bleached or dyed in a wide range of colours. Prime quality feathers are manufactured into elegant fashion accessories. Other types of feathers are used for cleaning fine machinery and equipment as well as for decorations. The quality of the feathers produced from ostriches raised in Europe and North America, however, differs from those produced in Africa. The best feathers come from the more arid regions of the world.

Feather harvesting

At the age of six months, "chick" feathers are replaced by juvenile feathers that become fully "ripe" at about 16 months of age. This is the usual age for first plucking. Soon afterwards, adult plumes develop and a new crop of feathers occurs every eight months.

Birds to be plucked are herded into a paddock and are then individually caught by the neck with a shepherd's crook (see Chapter 9 for ostrich restraints). Each bird is guided into a wooden ostrich crush and kept calm by hooding. The wing plumes are clipped and the ripe body feathers plucked. When the remaining stubs of the wing feathers are dry, they should be extracted in order to make way for the next growth.

Three terms are associated with feather harvesting:

Plucking: refers to removing the whole feather, plume or quill from the socket by pulling it out with the hand (coverts, tails, floss and bodies).
Clipping: the plumes and a short piece of the quill are clipped, usually with pruning shears, leaving the "green" stubs in the socket to ripen (wing quills).
Quilling: refers to drawing or extracting the dry ripe quill stubs that have been left in the sockets at the time of clipping. Quill stubs take about two months to ripen.

Classes of feathers

The ostrich produces many types or classes of feathers. Sex, age, location of feathers on the body, and different stages of development are the determining factors. Commercial classification of ostrich feathers is basically as follows:

Whites. These are the 24 male wing feathers in one row on each wing (total 48), which are grouped into primes, firsts, seconds, thirds, stalky and inferior, according to quality and length.

Blacks. Male wing feathers (coverts) other than the whites. They are normally black.

Famines. The female wing feathers, which are classified according to the colour shade either as light or dark, and then grouped as the whites above.

Drabs. The female wing coverts.

Floss. One row of feathers under the wing and chest. They are termed "black floss" in the male and "drab floss" in the female. Depending on the race, female ostriches may also have "silver floss" or "blonde floss".

Bodies. Body feathers that are termed "black bodies" in the males, "drab bodies" in the females, and "chick bodies" in chicks.

Tails. Tail feathers vary in colour from white or white/brown in males to light brown or dark brown in females.

Spadonnas. These are the chicks' wing feathers, and are normally classified as white, coloured or dark.

Commercial characteristics of ostrich feathers

Ostrich feathers are sorted and graded according to the following characteristics:

Feather length. A feather's value is generally proportional to its length. As a rough guide, good wing feathers should be at least 70 cm long while top quality floss or bodies should be at least 33 cm.

Feather breadth and shape. The broader the feather the more valuable. A good wing feather should be 30 cm wide and the distribution and length of the flues should be equal on either side of the shaft (i.e. symmetrical, with parallel sides and even widths); the tip should be rounded.

Density/compactness of flue. These depend on the closeness of both the barbs and barbules and the length of the barbules (see Figure 54). Uniform compactness throughout the plume is also important.

Strength of flue. The strength of the barbs is assessed from their angle to the shaft. Barbs should not have more than a 90° or right angle to the shaft as this reduces the effective width of the feather.

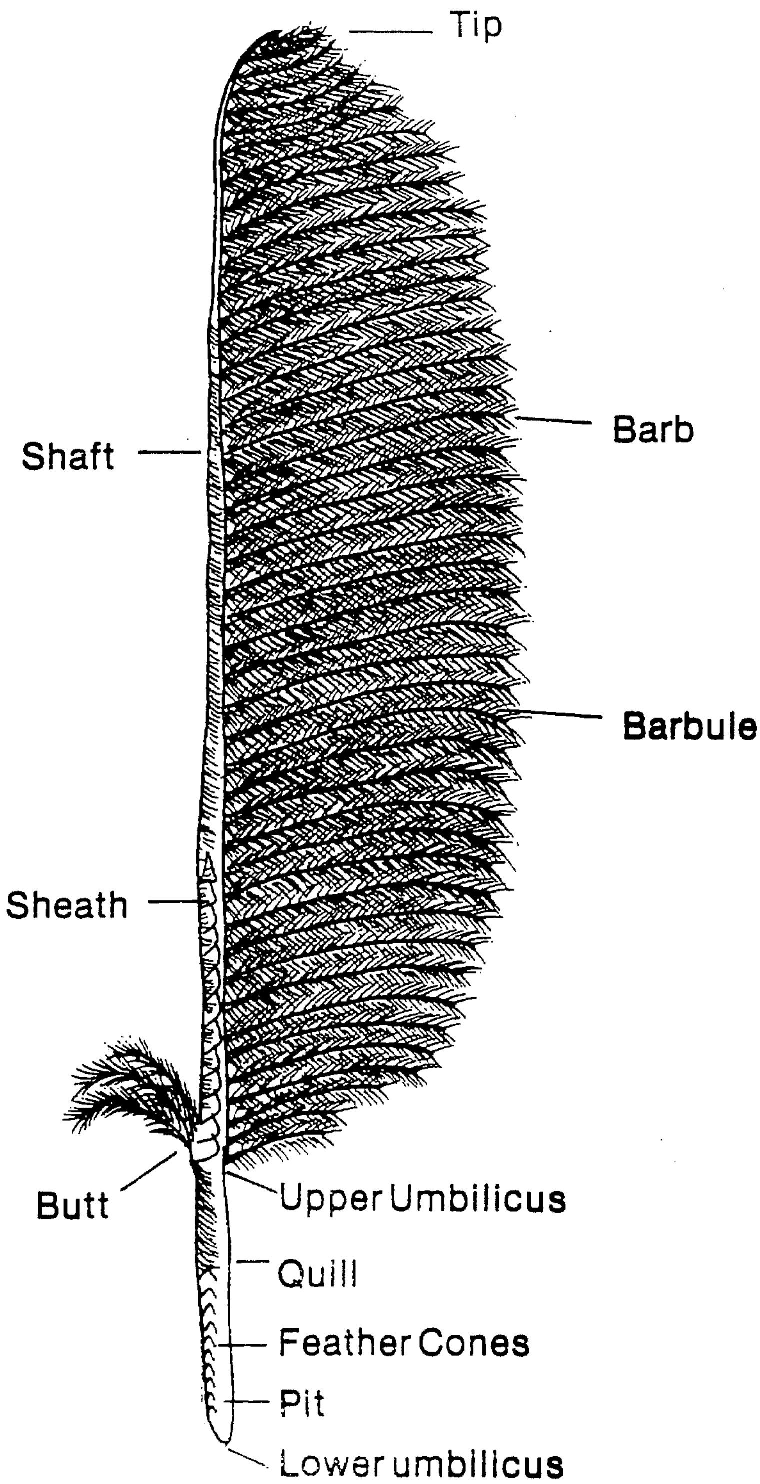
Thickness of shaft. The shaft should be narrow but strong enough to permit a graceful curvature to the feather.

Freedom from defects. This also includes the texture, silkiness and gloss of the barbs. Defects or feather bearings are caused by external parasites, nutritional deficiencies, ambient temperature or sudden dietary changes.

OTHER OSTRICH PRODUCTS

Infertile eggs are decorated and sold as ashtrays, boxes, lamps or just as decorative ornaments. Ostriches are also being exploited for medical and medicinal purposes. The tendons of the ostrich leg are long enough and strong enough to replace torn tendons in the human leg. Recent research in ophthalmology points to the possible use of ostrich eyes in cornea transplantation. Ostriches have the ability to see clearly for more than 12 km and the cornea is large enough to be trimmed down to fit the human eye. Furthermore, the ostrich brain produces a substance that is being studied for the treatment of Alzheimer's disease and other forms of dementia.

FIGURE 54
Structure of the ostrich feather



Chapter 9
Diseases and medical management of the ostrich

HANDLING AND EXAMINATION OF THE OSTRICH

There are several occasions where the physical handling and examination of ostriches may be necessary, such as sexing, microchipping, transporting, illness, injury, blood withdrawal, administration of certain medications and evaluation for breeding potential.

Handling

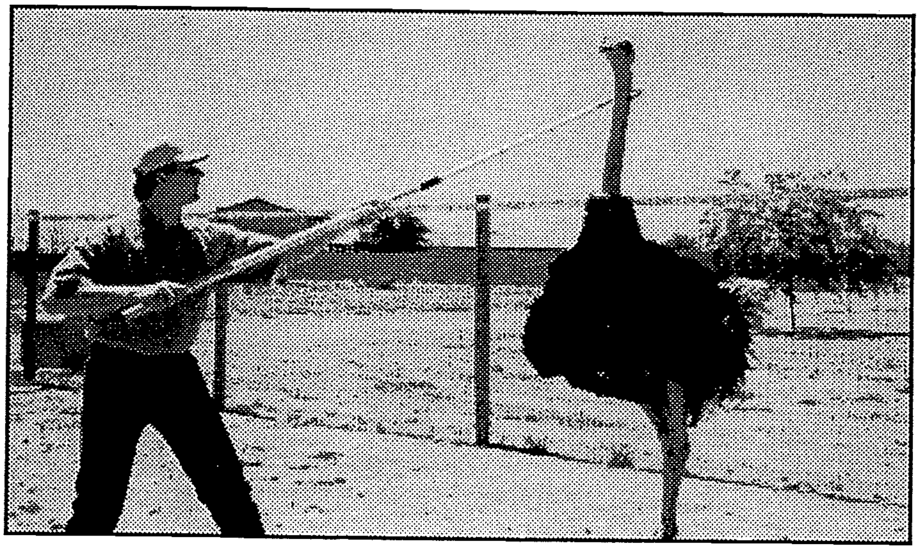
It is always advisable before physically handling the birds to herd them gently into small working areas. This can be done by using "boards" in the case of young birds or mobile gates, hurdles (on wheels) or large shields in the case of large birds. If individual birds are sought, the birds should be moved together in a group and only at the last moment should the necessary bird be caught. This will greatly facilitate safe capture and will also help reduce undue stress to the birds.

Young ostriches under 15 kg in weight do not normally pose any great problems for experienced handlers. Ostrich chicks should be handled with the greatest care as they are very fragile creatures. The chick can be cradled in one arm with a slight hand pressure on its back to prevent it from kicking free and falling. It can also be carried with one hand slipped between the legs and the other hand applying slight pressure at the base of the neck. Under no circumstances should chicks or young birds be grasped or carried by the neck or legs as this may cause permanent injury. When placing small birds back on the ground, it is wise to stabilize them for a moment in order to avoid uncoordinated or rushed takeoffs when they are released.

For birds over 15 kg, several techniques can be employed, depending on individual size. Juveniles may be restrained by placing one hand under the thorax and the other hand under one leg next to the abdomen, lifting the bird off the ground. After a few seconds of excitement and kicking, the bird will accept the restraint and will often relax its legs. Wing restraint by two people is often adequate for birds up to seven months of age. Care should be taken, however, as the wings are quite fragile and may easily be broken. Approaching the bird from behind and forcing it to the ground (with continuous downward pressure), is a successful technique for birds up to eight or nine months old.

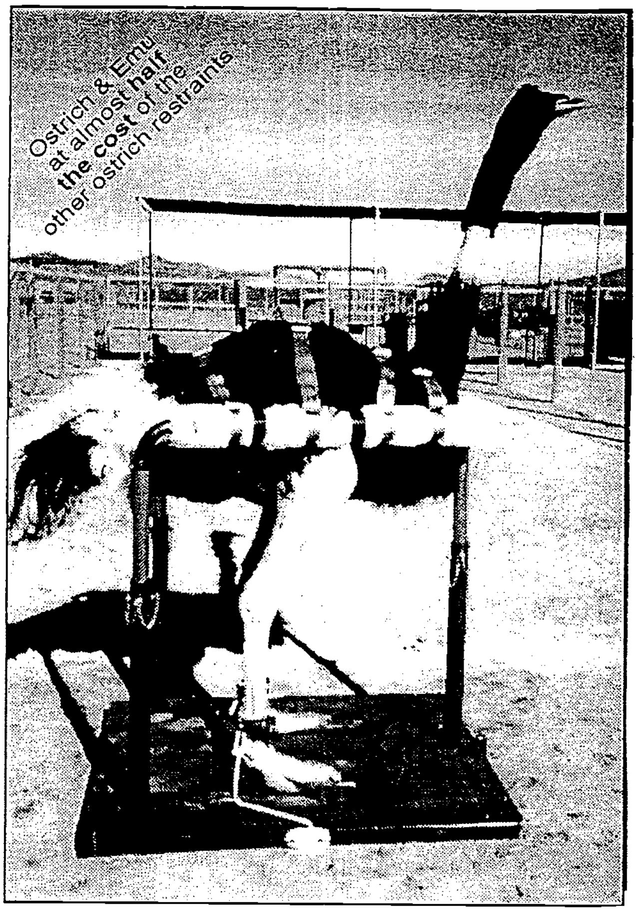
For adult or birds over one year of age, different techniques are needed. Birds of this age should be treated with the greatest respect, particularly if it is the breeding season. The handler should bear in mind that an adult male ostrich can kick with a force of up to 225 kg. Ostriches kick only forwards-downwards and backwards or sideways. An adult male during breeding should not be underestimated since it will attack with the minimum of provocation, or none at all. It is the male prerogative to protect his females and their eggs, and this should be respected. If chased by an ostrich, the handler should not try to outrun it, but should simply lie flat on the ground. As the bird cannot kick when the handler is lying flat, it may just stamp on the handler which is far less harmful. Females are usually calmer and more even-tempered and are thus easier to handle.

FIGURE 55
Ostrich hook (or crook) used for handling adult ostriches



The basic principle is to "hood" the bird as quickly and as gently as possible. Hooding, by covering the bird's head and eyes, will disorient the bird and allow it to be manoeuvred into a holding pen or ostrich crush (see next section). To do this successfully, the handler can either exploit the ostrich's inquisitive nature, or use a shepherd's crook. The handler first rolls the hood up over one hand. As the curious bird approaches to peck at the hood, its beak is grasped by the hand with the hood. The free hand then quickly unrolls the hood over the bird's head and down the neck. For an experienced handler, this method takes about five seconds. In the second method, a shepherd's crook can be used to pull the bird's head down (see Figure 55) so that it can be grasped by the handler or an assistant, and the hood unrolled over the head. The bird can then be manoeuvred by two or three people - one on each wing and one behind the rump. Handlers at the wing should hold the wing close to the body in the axillary position, while the person at the rump pushes the bird forward, even pushing the tail over the back. Hoods may be made from virtually any fabric, even from old clothing. Since the aim is to obstruct the bird's vision, hoods should be opaque, soft, and long enough to cover the bird's head and part of its neck.The handler should avoid covering the bird's nostrils, since this may hinder its breathing.

FIGURE 56
Ostrich crush or restrainer



Other methods sometimes used for handling and restraining adult ostriches are either to grasp the head or to grip the inside corner of the lower mandible, by applying slight pressure, and then rapidly push the head down to the ground. When first captured in this way, the bird will fan its wings and make hopping efforts to free itself. It will frequently back up several paces before eventually sitting in the sternal position. Extreme caution should be exercised by the handler to avoid causing serious injuries to the head, neck and beak. The beak area in particular has a rich innervation and is therefore very sensitive. Excessive force backwards on the head against the neck can split the beak, dislocate the neck and even kill the bird.

Ostrich restraints

The use of the shepherd's crook has been described earlier. The width at the narrowest part of the crook should be sufficient to place over the bird's neck. Extendible hooks made of lightweight fibreglass are available to ensure the safe capture of adult birds. They extend to over 2.5 m and retract to 1.5 m (Figure 55).

To restrain an ostrich once hooded, an ostrich crush is necessary. This is basically a simple triangular structure that allows the ostrich to be manoeuvred inside it while restricting its movement. It can be made from solid wooden bars or metal pipes, each approximately 1.2 m long and 1.2 m high (Figure 56); padding the bars prevents any injury to the bird. The narrow front should also be padded and be no less than 70 cm wide to allow the bird's chest to rest against it comfortably. A crossbar is fitted at the back of the crush to prevent the bird from backing. Straps can then be placed over the bird's back. The ostrich crush shown in Figure 56 is one of the new designs that allow the height to be altered according to the size of the bird. Note that the bird's own weight on the base prevents it from moving the crush. Figure 57 shows a mobile weighing apparatus used for ostriches.

The sick ostrich

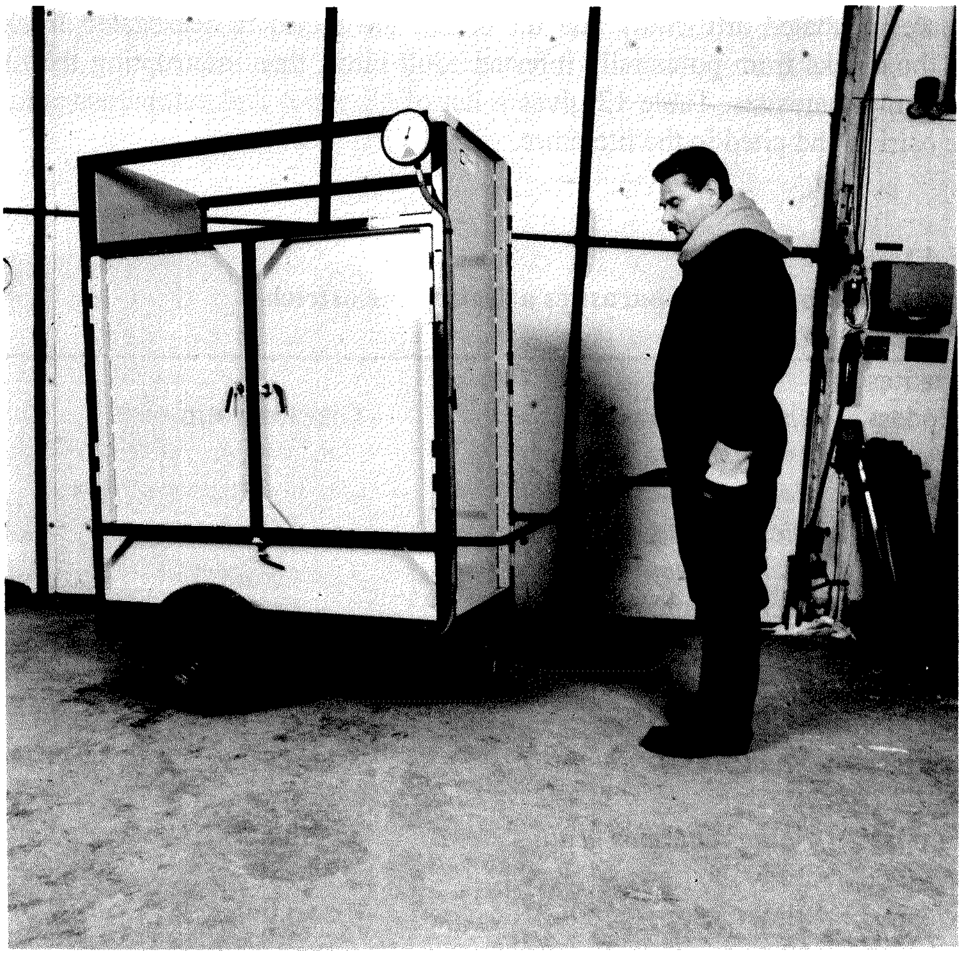
Ostriches display a number of health parameters that can be observed visually or by simple physical examination. Posture and general behaviour can tell the experienced eye a great deal about the bird. A healthy bird will generally be characterized by the following features. It:

- holds its neck erect and head high;
- spends a lot of time feeding or pecking the ground;
- has a bouncy walk;
- has symmetrical wings and legs;
- is curious and lively;
- stays with the group;
- exhibits clean lines along the neck and abdomen;
- has well-groomed feathers;
- has part clear and watery, part white and mucous or thick urine; and
- has dark, firm dung.

A sick bird normally exhibits exactly the opposite characteristics (Figures 58 and 59). One or more of the following will be evident:

- a droopy head and neck, adopting a submissive or depressed posture;
- poor appetite;
- it is inactive, lethargic or listless;

FIGURE 57
The ostrich weigh-chute (courtesy of Heebner Enterprises, Canada)



- uncoordinated walking;
- asymmetry of wings and/or legs, deviation of the neck and spine;
- stays separate from the group;
- irregular breathing;
- peaked back and thin emaciated (pinched) abdomen;
- discoloured urine;
- dung may be hard, runny, pale, mucous-covered, or absent all together.

In the following sections, diseases that have been identified with the ostrich are discussed.

OSTRICH PARASITES

The prevalence of internal endoparasites in farmed hand-raised ostriches is low in comparison with pasture-raised or free-roaming birds. In commercial ostrich operations, the eggs are incubated artificially and the chicks are raised in segregated flocks. This separates the chicks from potentially infested adult birds, thus interrupting the life cycle of most internal parasites. Table 12 gives a list of all endo- and ectoparasites known to affect the ostrich and cited in the literature.

TABLE 12
List of known endo- and ectoparasites affecting the ostrich

Endoparasites		
Nematodes:	*Amidostomum anseris*	- Gizzard worm
	Ascaridi struthionis	
	Codiostomum struthionis	
	Dicheilonema filiform	
	Dicheilonema rhea	
	Dicheilonema spicutarum	
	Libyostrongylus douglassi	- Wireworm (stomach worm)
	Paronchocerca struthionis	- Filarial lungworm
Cestodes:	*Houttynia struthionis*	- Tapeworm
Trematodes:	*Philophthalmus gralli*	- Eyefluke
Protozoan:	Eimeria spp.	- Coccidiosis
	Histomonas meleagridis	- Causing blackhead
Ectoparasites		
	Struthiolipeurus struthionis	- Ostrich louse
	Family *Pterolichidae*	- Quill mite
	Amblyomma gemma	- Bont tick
	Hyalomma albiparmatum	- Bont-legged tick
	Rhipicephalus appendiculatus	- Brown ear tick

Most of these parasites are of minor economic importance. The following parasites, however, have been recognized as causing serious losses.

FIGURE 58
Signs of a sick ostrich chick

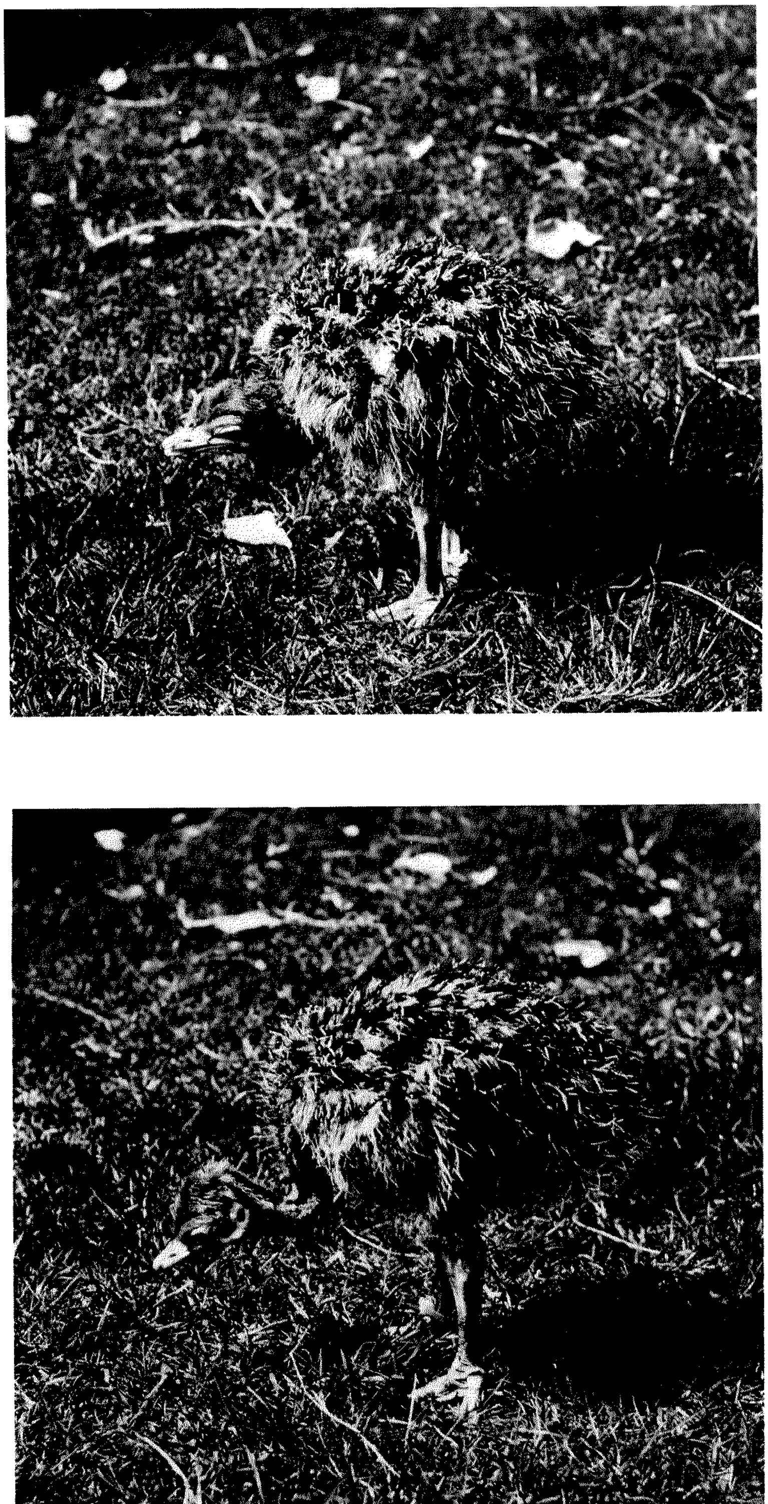
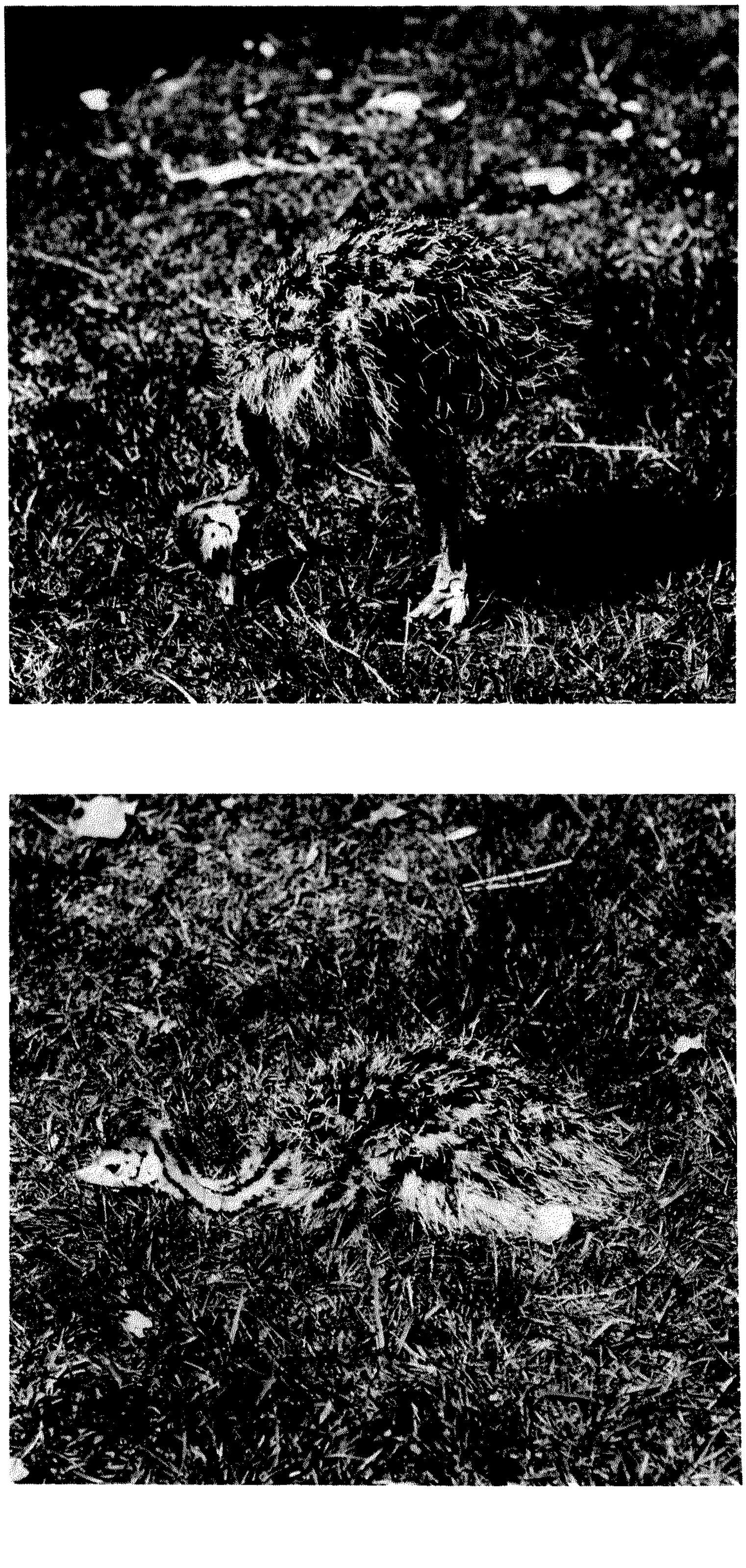


FIGURE 59
Further signs of a sick ostrich chick



Ostrich wireworm (or stomach worm)

This is one of the most problematic nematode parasites in Africa and is exclusive to ostriches. The worm inhabits the proventriculus (hence the name stomach worm), and can cause severe pathological changes in this region. The adult worms are 0.5 to 1.0 cm long, reddish-brown in colour and very thin and wire-like. Eggs are passed in the faeces and remain viable for up to three years. In the presence of warmth and moisture, the eggs develop into infective larvae. Once ingested, the larval form develops into adults in about three weeks. Young ostrich chicks are particularly susceptible to this parasite. Heavy infestation can produce impaction of the proventriculus, and may lead to a high mortality rate.

Symptoms. Infected birds exhibit loss of appetite, lethargy, loss of condition, paleness at the back of the mouth (a sign of anaemia), enteritis (in chronic cases) and constipation (where impaction of the proventriculus occurs). Mortality is normally high in chicks.

Pathology and diagnosis. The presence of wireworms in the proventriculus or under its lining at post mortem; eggs in faeces samples using the flotation method; pale carcass and organs; liver small and yellowish.

Treatment and control. Levamizole is the first highly effective anthelmintic medication to be used against wireworm. Recent evidence, however, indicates that the parasite appears to have developed resistance to this product. The benzimidazole group of compounds is now the preferred treatment, i.e. fenbendazole at a dose of 15 mg/kg orally and oxfendazole at 5 mg/kg orally. It is important to note that once the premises have been infected, regular treatment of chicks and young birds is essential (every three to four weeks). To avoid the worm developing resistance to particular medication, it may be necessary to alternate two or even three types of medication. All new birds should be checked on arrival at the farm.

Ostrich tapeworm

The ostrich tapeworm is a common problem in pasture-raised ostriches, particularly in southern Africa. The worm inhabits the small intestine, and can cause gradual emaciation through continuous starvation of the birds. The mature tapeworm is segmented, approximately 60 cm long, and white in colour. Eggs are passed in the faeces and develop into the immature form inside an intermediate host. The host for the ostrich tapeworm is not yet known. When the intermediate host is ingested by the birds the parasite develops into the adult form. The tapeworm species *Houttynia struthionis* is exclusive to ostriches and rheas.

Symptoms. Ostrich chicks are the most susceptible and show signs of infestation very slowly: gradual loss of condition, lethargy and anaemia, sometimes accompanied by mild diarrhoea.

Pathology and diagnosis. Presence of the worm in the small intestine at post mortem; segments of the worm or eggs in faeces.

Treatment and control. These are the same as for wireworm but fenbendazole is given at the higher dose of 25 mg/kg, in addition to resorantel (administered orally) at 130 mg/kg. Such a combination is most effective in eliminating the parasite, particularly if the treatment is repeated after six weeks.

Nematodes

The nematode *Codiostomum struthionis* is exclusive to ostriches. It inhabits the large ntestine and interferes with water absorption. It is about 1-1.5 cm long and white in colour.

Symptoms. No obvious symptoms.

Pathology and diagnosis. Presence of nematode in the colon at post mortem; eggs may be identified in faeces.

Treatment and control. Same as for wireworm.

Eyefluke

This is a parasite that can infest the ostrich as well as several other birds. It requires specific freshwater snails as intermediate hosts. It affects the eye and inhabits the conjunctival sac, leading to conjunctivitis and lacrimation. It is extremely small, no longer than 2-3 mm (Figure 60)

Treatment and control. Localized treatment of the conjunctival sac with 5 percent carbamate powder; second treatment after 48 hours.

Protozoa

Coccidiosis has been recognized in ostriches in many parts of North America and Europe, particularly where ostrich chicks are raised indoors in confinement. It is a disease condition of the digestive tract caused by the protozoan coccidial parasite. The genus *Eimeria* has been identified but the species is as yet unknown.

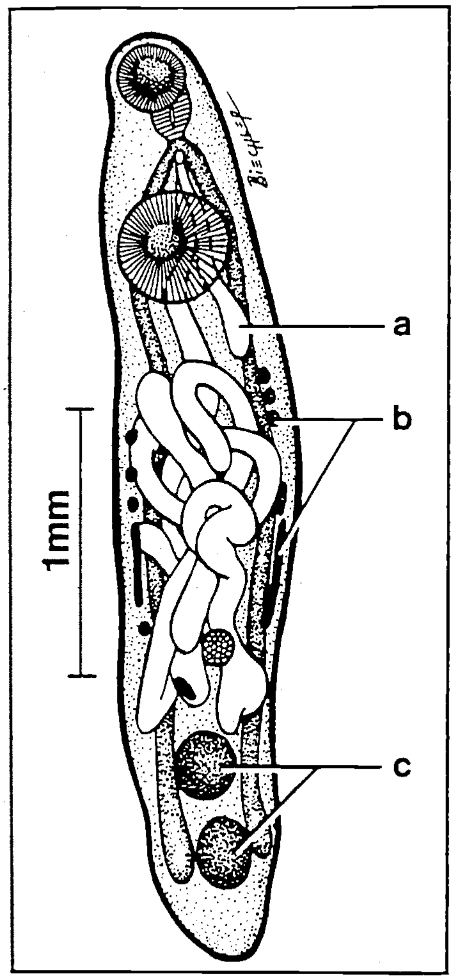
Symptoms. Symptoms are usually minimal in ostriches. Infection can only be properly diagnosed by post-mortem examination. Infected birds generally exhibit loss of appetite, weakness, ruffled feathers and a hunched posture and their droppings may contain blood.

Pathology and diagnosis. Presence of protozoan parasite in the ostrich's digestive tract and faeces.

Treatment and control. Regular use of anti-coccidial drugs is the best treatment. If outbreaks occur, increased dietary levels of vitamin K as well as sulphonamides and vitamin A supplements hasten recovery. Ammonia fumigation of buildings between batches of chicks appears to be an effective control of coccidiosis.

FIGURE 60
Drawing of an adult eyefluke (*Source*: Chiodini, 1980)

(a) cirrus sac (b) vitelline glands (c) anterior testis



External parasites

Insects, including lice, mites and ticks, are the most common and widespread ectoparasites affecting ostriches of all ages. Birds infested with ectoparasites generally exhibit irritation and react by scratching. Lice and mites can be found by examining the skin and feathers, especially around the vent, legs, wings and neck. Night-time examination of birds may detect parasites that feed at night, but specific identification of the parasite requires microscopic examination.

Lice of the genus *Struthiolipeurus* can cause feather damage and feather loss. Mites of the family Pterolichidae are known to infest ostriches. These microscopic mites live within the shaft of the feather. Damage is done to the feather when the mites pass through the quills during their life cycle. The presence of the quill mites causes the birds to pull their own feathers, damaging the skin. Apart from feather loss, the stress caused may predispose the birds to other health problems, such as respiratory problems, and also reduce their reproductive ability.

Ticks of various species (see Table 12) infest ostriches. High infestation is associated with areas of high rainfall and dense vegetation Thus the most common site of attack is the head and neck. The negative economic significance of ticks for the ostrich industry is twofold. First, ticks not only cause discomfort to the birds but also mark the hide, thus reducing its value. Second, some species of ticks are known carriers of the rickettsial organism that causes "heartwater disease".

General treatment and control. Ectoparasites are generally minimized by sanitary measures. Ivermectin therapy (ivomec) is successful against most ectoparasites and endoparasites at a dosage of 0.2 mg/kg subcutaneously, repeated monthly for three treatments. For heavy infestation of ticks, a 5 percent carbaryl dusting twice within two weeks is extremely effective.

BACTERIAL DISEASES

Omphalitis and yolk sacculitis

This is a disease condition caused mainly by *Escherichia coli* infection. When the bacterial infection is localized in the umbilical area, it is termed omphalitis (navel infection), while infection of the yolk sac is termed yolk sacculitis (yolk-sac infection). These are major causes of death of chicks before and after hatching. The condition is characterized by an inflammation of the navel, incomplete yolk sac resorption (retained yolk sac) and improper healing.

The diseases can produce either acute or chronic signs. As the yolk sac is the focus of infection, many embryos die before hatching, usually late in the incubation period. With the acute form, chicks die suddenly shortly after hatching, with losses continuing for six to seven days. In the chronic form, the chicks show retarded growth with deaths occurring up to three to four weeks after hatching.

Faecal contamination of hatching eggs is considered to be the most serious source of infection and the condition is promoted by placing dirty eggs in the incubators, thus contaminating other eggs with the bacteria, which penetrate the eggshell. High humidity inside the incubator aids the spread of infection. Low brooding temperature increases the incidence of mortality.

Symptoms. Chicks show enlarged abdomens, moist inflamed navels and lack of body tone. Sudden death in the first few days after hatching is associated with the acute form of infection. Retarded growth or complete absence of growth, loss of weight which may be accompanied by dehydration, and death three to four weeks after hatching are signs of the chronic form.

Treatment and control. E. coli is sensitive to antibiotics (e.g. ampicillin and choramphenicol). However, treatment may prove to be ineffective in the acute form since most affected chicks will probably die before they begin to eat or drink. In the chronic form, once diagnosis is confirmed, affected chicks should be immediately isolated (to prevent the spread of infection) and treated with antibiotics in combination with complete nutritive replacement or energy packs. Undoubtedly the best way to combat the condition fully is by prevention through the adoption of high standards of hygiene. Breeders should be careful to disinfect all equipment and establish routine fumigation and disinfection of incubators, eggs and brooding quarters.

Botulism

This is caused by ingesting the toxins of *Clostridium botulinum*, a bacterium that causes deadly poisoning. Losses in ostriches are most commonly caused by the type C toxin.

Symptoms. Drowsiness, weakness and impairment of walking are the earliest signs. Depending on the amount of toxin ingested, the signs can progress into complete paralysis of legs, neck and wings. The birds eventually die.

Treatment. The administration of a type C antitoxin results in almost total recovery of affected birds. It is also possible to immunize ostriches with injections of the type C toxoid which contains the Clostridium antigen. The disease can be prevented by proper management procedures.

Anthrax

Ostriches are the only birds susceptible to anthrax. It is a per-acute or acute febrile infectious disease caused by *Bacillus anthracis* and characterized by rapidly fatal septicaemia. Its distribution is practically worldwide, particularly in areas where the air temperature is in the range 36-42°C and relative humidity above 60 percent. Transmission is mainly through ingestion of the bacillus or spores, but transmission by biting flies has also been reported.

Symptoms. Birds become feverish, weak and delirious. Swelling of the throat may also occur. This is accompanied by a rapid rise in body temperature. Death occurs fairly quickly, with blood oozing from the cloaca and nostrils. The need for rapid diagnosis cannot be overemphasized. This is carried out by examination of blood smears, preferably stained with geimsa rather than the more usual polychrome methylene blue. Immediately after the death of the birds, swabs of blood from the cloaca or nostrils should be sent for laboratory bacteriological isolation. If the birds have been treated with penicillin, the organism will not be found in the bloodstream, but may be present in the lymph nodes and spleen.

Treatment and and control. Penicillin is effective if given soon after the temperature rises. Control depends on prompt diagnosis, proper disposal of dead birds by burning or burial, vaccination, and control of movement of unvaccinated birds into or from endemic areas. A spore vaccine is available that produces immunity in one week and lasts for one year. This vaccine should be used in areas where anthrax has been reported.

Campylobacteriosis

This is a new and extremely severe disease in ostriches. It is caused by the gram-negative bacterium *Campylobacter jejuni* and is a semi-acute to chronic disease that may result in high mortality among young birds between the ages of ten days to four months.

Symptoms. The first clinical signs are loss of appetite and the production of green-stained urine. Sick birds exhibit depression, anorexia and progressive weakness, and usually die within a few days.

Diagnosis. Post-mortem examination reveals severe focal necrosis of the liver, hydropericardium and ascites. Histological examination reveals extensive necrosis of the liver and congestion of the lungs.

Treatment. Antibiotic administration (broad spectrum types) in drinking-water in chronic cases or by injection in the semi-acute form (see Yolk sacculitis).

Necrotic (or ulcerative) enteritis

This is an acute disease that may affect ostriches of any age. It is caused mainly by the gram-positive bacterium *Clostridium perfringens* type C, but *Clostridium colimum* has been isolated from young ostriches. The disease spreads quickly through droppings and by direct contact and is sometimes related to mud eating.

Symptoms. Clinical signs are sudden depression, anorexia and death within 48 hours. Mortality in chicks may approach 100 percent.

Treatment. Prophylactic administration of streptomycin at a level of 0.5 g/litre of drinking-water (or 60 g/tone feed), 100 g bacitracin/tone feed, or 500 g chloramphenicol /tone feed normally provides protection against infection. Penicillin (or a penicillin-based antibiotic) is effective if given early once infection has been suspected.

VIRAL DISEASES

Newcastle disease (ND)

This is a highly contagious and destructive disease that attacks numerous wild and domesticated avian species, including the ostrich, causing respiratory nervous disorders. The incubation period of ND varies from 2 to 15 days after exposure, with an average of five to six days. Incubation time and severity of the disease decrease gradually from hatching to maturity. An outbreak may be so acute and severe as to kill all or nearly all the birds in a flock within four to six days. In ostriches, ND may lead to 80 percent mortality in unvaccinated flocks. At the other extreme, when the disease is in a subclinical stage, it may be so mild that symptoms are scarcely noticeable or are absent altogether.

Symptoms. Symptoms vary considerably according to the strain of ND virus. Signs appear first in young birds. In the clinical stage, the neck becomes limp, while the head is bent in a torticollis posture. Difficulty in breathing, coughing and gasping develop within 6-12 days. Rhythmic tics of the cervical muscles are observed, followed by loss of balance, the inability to stand up, and even total paralysis within a few days. There may be oedema (swelling) of the head and around the eyes. Mortality in ostriches is about 30 percent in adults and as high as 80-85 percent in immature chicks.

Diagnosis. Isolation of the virus from the brain. In ostriches, isolation of the virus from the liver, spleen, heart or kidney is normally unsuccessful. Blood testing of suspected birds for the anamnestic response in the titre of the haemagglutination inhibition (HI) test, is one of the most effective diagnostic methods (Table 13). The test should be repeated after 15 days.

Treatment. As it is a viral disease, there is no specific treatment for ND. A vaccination programme is eminently effective in combating such a highly contagious disease.

TABLE 13
HI titres for ND antibodies in an ostrich flock following an outbreak of the disease

Days from onset of signs	Mean HI titre
3	2.5
17	4.4
44	8.0

Source: Samberg *et al.* 1989.

Avian pox

Avian pox is a slow-spreading viral disease, characterized by typical macroscopic and microscopic skin and throat lesions. The pox is prevalent worldwide, affecting all birds of all ages. The virus is transmitted by air, insect vectors (usually mosquitoes of the genera *Cules* and *Aides*), or by eating infected scabs (dry skin crusts showing the pock-like lesions). The incubation period in ostriches varies from six to ten days.

Symptoms. Wart-like lesions on the skin of the head, eyelids, around the external ear opening, on the beak, and on the skin of the neck. In the most affected birds, large crusts develop in the eyelids, resulting in total closure of the eyes. In the wet form of the disease, lesions are found in the mouth, at the base of the tongue and in the pharynx and larynx. Mortality in ostriches is normally low (15 percent), and is mainly caused by the bird's inability to eat or reach food and water.

Diagnosis. The isolation of a viral agent able to cause pock lesions in embryo membranes is important to differentiate pox from mycotic dermatitis and vitamin B deficiency.

Treatment. There is no specific medical treatment for birds infected with avian pox virus. Scabs can be treated with silver nitrate for four to five days to prevent secondary infections. Vaccination with a commercial fowl pox vaccine at 10 to 14 days of age is recommended. Mosquitoes should be controlled as much as possible.

Avian influenza

This disease was one of the first to be recognized as being caused by a virus in 1901 and the viruses were termed "fowl plague viruses". These terms were used in the past to describe a distinct clinical disease ("the classical disease") that involved extremely high mortality. In 1981 it was recommended that such usage be abandoned except in reference to certain classical viruses. The suggested term for viruses causing clinical disease involving high mortality is "highly pathological avian influenza" (HPAI) viruses.

Symptoms. The clinical signs of avian influenza may vary considerably with age and strain of infecting virus. Classically, the clinical signs of HPAI are a sudden onset of high mortality, complete cessation of egg laying, respiratory signs, rales, excessive lacrimation, sinusitis, oedema of the head and face, diarrhoea, and green discoloration of urine. In infection with less virulent viruses, signs range from drop in egg productivity, respiratory disease, anorexia, depression, sinusitis, and low but elevated mortality (50 percent). When other organisms are present and exert an exacerbative or synergistic effect, or when the birds are under stress, mortality may rise to as high as 70 percent. The severity of the disease in newly hatched ostrich chicks is much greater and mortality may be as high as 90 percent.

Diagnosis. Isolation of the virus from affected ostriches and a positive sero-conversion.

Treatment. No treatment is available and no avian influenza vaccines are available at present. Prevention is the only course of action to control the spread of the disease.

MYCOTIC DISEASES

Aspergillosis

This is a respiratory disease that can cause a severe problem in ostrich flocks. It is normally caused by the fungus *Aspergillus fumigatus.* However, *A. flavus* and *A. niger* fungi have been isolated in several cases of aspergillosis in young ostrich chicks. Spores of this fungus are transmitted through contaminated (moulded) litter or feed and also through inhalation of spores in contaminated hatcheries.

Symptoms. Clinical signs appear between three to eight weeks of age, with depression, anorexia, stunting and mortality (up to 50 percent). Contrary to other avian species, and despite severe gross lesions in the lungs, ostriches do not show any clinical signs of respiratory distress.

Treatment. Treatment of affected birds is generally regarded as useless. A solution of copper sulphate (1:2 000) in the place of drinking-water may be used to prevent the disease spreading further. Control is best established by removing the cause. A careful search should be made for mould in litter, feed, feed and water containers together with efficient disinfection of the hatchery (post hatching) with formalin and potassium permanganate (55 ml and 35 g, respectively per cm^3).

Candidiasis

This is caused by the fungus *Candida moniliformis.* In ostriches the problem is usually related to long-term treatment with antibiotics. The fungi affect the mucus of the mouth and oesophagus, causing anorexia, dehydration and death.

NUTRITIONAL DISORDERS

Deficiencies or disturbances in the nutrition of an ostrich cause a variety of diseases and may be the result of several factors. For example, the amount of a particular nutrient in the feed may be insufficient to meet the ostrich's requirements; the diet may contain a substance that inactivates the nutrient or inhibits its absorption or utilization; or the metabolism of the ostrich may be deranged by the interaction of dietary, environmental and genetic factors.

When a micronutrient such as a vitamin or a trace element is involved, a characteristic syndrome is produced that reflects the specific functions of the nutrient in the metabolism of the bird. The trace elements and water-soluble vitamins are essential components of the enzyme systems, while fat-soluble vitamins help to maintain the integrity and function of membranes. Deficiencies of these nutrients have profound effects that are out of proportion to the minute amounts of the nutrients involved.

Only those nutritional disorders that are most commonly encountered in the field are described. It is important to note that where scientifically formulated diets are available, simple dietary deficiencies occur very infrequently and outbreaks are usually caused by either the accidental omission of a nutrient supplement or preservative, the inactivation of an unstable vitamin during storage, or the dilution of the diet with grain. However, nutritional disorders may also arise as the result of excessive dietary levels of some minerals and vitamins.

Vitamin A

Vitamin A is essential for growth, optimal vision and the integrity of the mucous membranes. As the linings of the digestive, urinary, genital and respiratory systems are made of mucous membranes, it is in these areas that lesions resulting from vitamin A deficiency are most readily observed. The mucous-secreting cells in the conjunctiva, nasal sinuses, oesophagus and trachea become keratinized and cease to function. In addition to its role in preserving the integrity of mucous membranes, vitamin A protects against infection, probably by promoting antibody production. Signs of secondary infections are frequently evident in deficient birds, particularly in the respiratory tract, intestine and kidneys. Skeletal abnormalities are produced in young birds by derangements in bone growth and cartilage development. An excess of the vitamin is toxic, producing skeletal deformities and damage to membranes.

Symptoms. Signs and lesions of feeding a diet severely deficient in vitamin A develop usually within two to three months in adult birds. Weakness, ruffled feathers and a drop in both egg productivity and hatchability are the first signs. In more advanced cases, a watery nasal discharge is observed and a sticky white substance accumulates in the eyes, causing impaired vision. Embryonic deformities such as an enlarged head and lack of one or both eyes are indicative of vitamin A deficiency in the mother's diet. If hatched, the chicks show non-specific features of vitamin A deficiency including retarded growth, emaciation and poor feather development.

Treatment. The inclusion of a stabilized vitamin A preparation in the diet at the rate of 12 000 IU/kg. Absorption of vitamin A is rapid and birds not in advanced stages of deficiency will respond promptly.

Vitamin D

This vitamin, in the form of its hormone-like metabolite, induces the transport and absorption of calcium and phosphorus from the intestine to form normal skeletons, hard beaks and strong eggshells. High levels of vitamin D are especially important when the mineral levels in the diet are borderline, or when the ratio of calcium to phosphorus in the diet is not ideal. It was indeed the discovery and use of vitamin D in the early 1920s that made the year-round production of poultry possible.

Symptoms. When the intake of vitamin D is inadequate, the mineralization of the skeleton is defective and rickets or osteomalacia is produced in young or adult birds, respectively. Skeletal deformities develop, especially in the legs, producing lameness and swollen hocks. The beak and claws become soft and pliable like the bones. Growth is retarded and feather development is poor. In adult birds, egg productivity and hatchability fall and eggs have soft shells.

Treatment. A single large oral dose of 10 000 IU D_3 can promptly cure deficiency symptoms. Vitamin D_2 should not be used in ostriches since it is poorly retained and utilized. Furthermore, excessive amounts of vitamin D_3 should not be added to feed.

Vitamin E

The importance of this vitamin is grossly underestimated in ostrich feeding. It is necessary for reproduction and the hatchability of eggs. The most potent form of vitamin E is α-tocopherol. The amount of vitamin E in the diet is governed to a certain extent by the content of selenium, which shows some biological properties of tocopherols. The main function of tocopherols is to protect the components of vital systems from oxidation.

Symptoms. Vitamin E deficiency produces several disease conditions that may occur separately or together depending on the age of the birds, the severity of the deficiency and various characteristics of the diet (e.g. unsaturated fatty acids and sulphur-containing amino-acid content). Deficiency in adult birds causes no obvious abnormalities apart from reduced hatchability as a result of embryo mortality caused by vascular lesions between day 6 and 8 of incubation. A marked and prolonged deficiency of this vitamin causes degeneration of the testes in the males with a subsequent marked drop in fertility of the eggs. In chicks and young growing birds, a vitamin E deficiency produces several disease conditions, including nutritional encephalomalacia and, depending on the type of diet used, may cause alimentary exudative diathesis, muscular dystrophy and enlarged hock syndrome, followed by the sudden collapse of the bird ("downer syndrome" or "downer ostrich").

In the early stages of encephalomalacia, the bird staggers about in a drunken fashion, falling over with violent spasms of uncoordinated movements. Paralysis develops, particularly in the neck, and death soon follows. Exudative diathesis is characterized by lesions in the capillary walls and a general increase in their permeability, causing slight haemorrhages and allowing blood plasma to pass through. The latter accumulates under the skin. Muscular dystrophy, which frequently accompanies exudative diathesis, involves the degeneration and necrosis of the muscle fibres.

Treatment. Treatment with vitamin E and selenium supplements is completely effective. Response to treatment is rapid and birds become normal within a few days.

Vitamin B

The vitamin B group forms the active part of most enzyme systems in the body involved in growth, maintenance of the normal function of the nerve tissues, metabolism and feather development. Vitamins B_2 (riboflavin), biotin, and pantothenic acid appear to be of particular importance in ostriches.

Symptoms. Low dietary levels of the above vitamins lead to specific and non-specific (general) symptoms. Riboflavin deficiency in young birds leads to the toe (particularly the large toe) curling downwards and inwards when walking or resting. This condition is known as "curled-toe paralysis", which is diagnostic. Some birds may show more severe paralysis without marked curling of the toe. The paralysis is caused by degenerative changes in the sciatic and brachial nerve trunks, the neuromuscular end-plates and the muscles themselves. The first signs of riboflavin deficiency in young birds are lowering of the head from its normal erect position and drooping of the wings. Biotin deficiency in young ostriches leads to perosis (discussed under manganese deficiency) and fatty liver and kidney syndrome. In the latter, the liver and kidneys become pale and enlarged because of the presence of excessive amounts of fat (twice to five times the norm) and are diagnostic of biotin deficiency. Pantothenic acid deficiency in the breeders' diet leads to a condition known as "stunted chick disease". Embryos die during incubation, showing severe oedema and subcutaneous haemorrhage. Those that do hatch are stunted, usually accompanied by severe dermatitis of the feet, mouth and eyelids. The eyelids often become stuck together with a viscous exudate.

Treatment. When the symptoms are long standing, irreparable damage may have already occurred and the administration of the vitamin concerned will no longer cure the condition. However, response to riboflavin supplement is rapid if nerve damage has not become irreversible. All conditions can be almost completely prevented by adding vitamins to the diet at the appropriate levels.

Manganese

Birds in general are much more susceptible to manganese deficiency than mammals because of the relatively poor absorption of manganese from the intestine. Absorption is inhibited further by the presence of excessive amounts of calcium and phosphorus in the diet. Manganese is an essential component in controlling the rate of gluconeogenesis and also in the activation of several important enzyme systems involved in the formation of bone and eggshell matrices. Consequently, skeletal deformities (such as perosis) and defects in shell quality occur when manganese intake is inadequate.

Symptoms. Chicks and young ostriches reared on a manganese-deficient diet show retarded growth and develop a crippling leg deformity known as perosis. This is characterized by gross enlargement and malformation of the knee (tibiometatarsal) joint, which causes the gastrocnemius tendon to slip out of position from its condyles at the back of the joint, pulling the leg laterally or medially (Figure 61). If both legs are affected, death results, since the chick cannot secure food and water. Manganese deficiency in adult ostriches causes a marked fall in egg productivity and hatchability. Embryonic malformations include shortening of the lower mandible, producing a "parrot" beak that is diagnostic of the deficiency. In viable chicks, a spastic condition may be evident soon after hatching; this is characterized by tetanic spasms and head retraction.

Treatment. Once the birds show signs of perosis, there is very little that can be done to cure them. Prevention, by ensuring that there is sufficient amounts of manganese in the diet, is the only course of action.

Table 14 provides a list of some relatively inexpensive feeds that represent good sources of specific vitamin supplements. Oil-palm fruit is particularly useful for the treatment of vitamin A and D deficiencies. Fish-liver oil contains 2 000 to 60 000 IU vitamin D_3/g depending on the type of fish (oily fish such as tuna and mackerel are highest oin this vitamin). Dried alfalfa meal is an inexpensive source containing reasonable quantities of vitamin D (approximately 1 200 IU/kg).

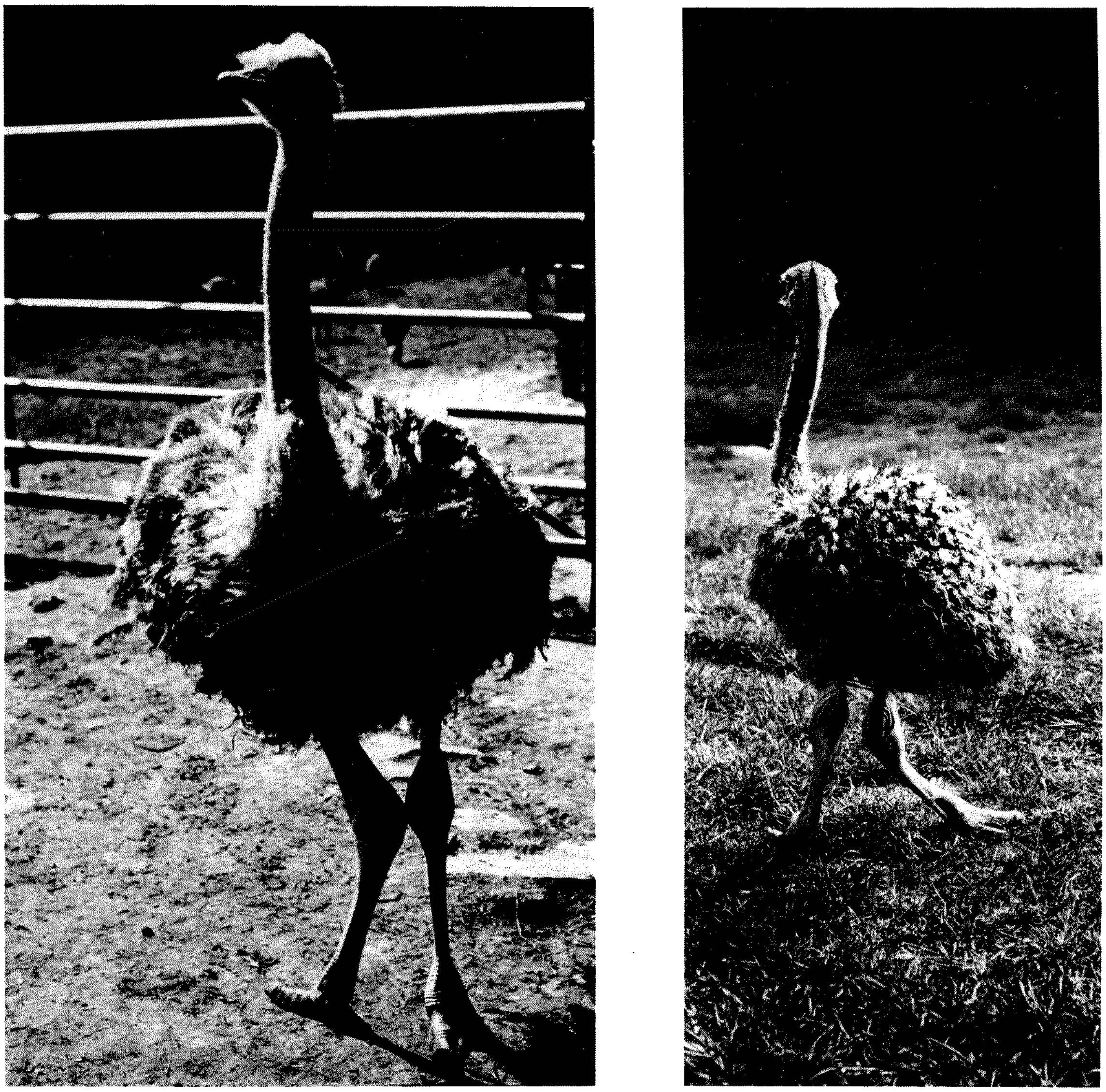
OTHER HEALTH-RELATED PROBLEMS

Impaction

Gastric impaction is a frequently encountered management problem especially during the ostrich rearing period. Ingestion of foreign materials may occur through improper management of the birds. Stress, in conjunction with access to foreign material in the environment, appears to be one of the main causes of indiscriminate eating, leading to impaction of the ventriculus or proventriculus. The transfer of birds to an unfamiliar substrate, use of unpalatable food, a high degree of food restriction, lack of food, use of excessive fibre in the feed, presence of unchopped grass or alfalfa stems, transport of the birds to a new farm or different enclosure, rearing the chicks without the benefit of experienced chicks or adults, lack of exercise of newly hatched chicks and ad lib presence of grit are some management faults that either separately or combined may cause gastric impaction.

Gastric impaction in ostriches may be either acute or chronic. In the acute form, there is a complete cessation of food and water consumption, although birds may be seen pecking at food and appear to be eating. In this form of impaction, the quantity of faeces produced is greatly reduced and urine becomes pasty. The condition of the birds deteriorates rapidly and death occurs within a few days. In the chronic form, the foreign material occupies space, which severely limits feed intake. The birds exhibit signs of malnutrition, including retarded growth, poor feathering and leg abnormalities. Palpation of the abdomen is the simplest and most effective way of diagnosis. Radiography may be used to diagnose impaction with excessive stones and other radio-dense materials, but is of little value in detecting impaction by plant stems and similar.

FIGURE 61
Leg rotation in ostriches



Laxatives or Epsom salts (magnesium sulphate), administered orally, may resolve mild chronic impactions. Surgical removal of the foreign material(s) is the only possible course of action in true cases of impaction or ingestion of foreign bodies.

TABLE 14
Some foodstuffs rich in specific vitamins

Vitamin A (IU/g)		**Vitamin E** (mg/kg)	
Algae meal, dried	800	Wheatgerm oil	1
430			
Alfalfa leaf meal, dried	500	Rye oil	970
Alfalfa whole meal, dried	300	Cottonseed oil	510
Grass, dried	200	Sunflower-seed oil	400
Alfalfa, fresh green	90	Safflower oil	330
Vitamin B (μg/g)			
	Riboflavin	***Biotin***	***Pantothenic acid***
Torula yeast, dried	46	1.1	80
Whey, dried	44	0.4	65
Brewer's yeast, dried	36	1.3	110
Liver meal	46	0.8	85
Safflower oil	5	1.4	10

Feather pecking and cannibalism

Feather pulling, feather eating and cannibalism are phases of a vice in ostriches of all ages and can be a serious problem in many ostrich flocks. This vice detracts from the market appearance of the birds and tends to reduce their value. Furthermore, the loss of feather covering increases the nutritional requirements for maintenance. The vice results from a complex interaction of many factors.

The vicious habit of pecking feathers, wings, nose, toes and other parts of the body is considered to be one of the serious problems in keeping ostriches in confinement. It is prevalent among chicks, growing birds and even mature ostriches and can lead to outbreaks of cannibalism if not promptly controlled. The habit is usually attributed to faulty management, overcrowding, overheating, underventilation, humidity, improper light intensity, insufficient feeding and drinking space, the presence of injured or sick birds, the housing together of ostriches of different ages, etc. The habit does not seem to be connected more to one subspecies than another.

To a lesser extent, the habit is also attributed to diets deficient in certain nutrients or containing too many of others. Too little protein, fibre, salt and bulk in the diet are known as possible causes of the vice. It is generally assumed that birds are prone to pick at rough feathers rather than at smooth ones and that feather pecking is a prelude to cannibalism. Excessive amounts of yellow maize in diets are said to favour the formation of curly or rough feathers and hence also favour the development of feather pecking. Available evidence, however, is insufficient to substantiate these views.

Light intensity has important effects on the behaviour of all birds including ostriches. If ostrich chicks are raised indoors, their activity will vary with light intensity. Outbreaks of feather pecking and cannibalism are more likely to occur under very bright light conditions. These outbreaks can be cured by simply reducing the light intensity. In general, the brighter the lights the greater the risk of cannibalism and feather pecking. Such a risk can usually be avoided by raising chicks in quarters that exclude daylight and where artificial light is evenly distributed.

There is some evidence that relatively high-fibre diets may help prevent or alleviate feather pecking and cannibalism in ostriches. This may partly be attributed to the influence of fibre on feather quality.

Cannibalism is prone to be troublesome when sand is used as litter. It is arguable whether the birds consume sufficient fibrous litter to help prevent cannibalism by virtue of the fibre consumed or whether the fibrous litter gives them more opportunity to work and less idle time to develop bad habits. Birds offered pelleted feeds appear to be more prone to developing a cannibalistic habit, which leads to the conclusion that cannibalism is primarily a vice brought about as the result of too much idle time, since the bird consumes its fill of feed in the form of pellets in less time and therefore has more idle time in which to get into mischief. It merely takes one ostrich to start pecking and the rest will soon follow, often leaving the ostrich victim completely naked by the next day.

Provided that the ostriches are kept busy, regularly exercised and provided with adequate quantities of balanced diet and good quality water, feather pecking and cannibalism should be kept to a minimum. However, where the habit persists, the addition of 2 percent salt to the diet for four to five days will control and stop cannibalism. Salt should not contain lumps as there is a danger of individual birds picking up too much salt at one time.

The salt cure against cannibalism, which is said to work in perhaps 99 percent of the cases under farm conditions, can simply be applied by using one tablespoonful of salt in 4.5 litres of drinking-water for one afternoon; the treatment is then repeated three days later for another half day. At the same time, it is desirable to check that the regular diet contains from 0.5 to 1 percent salt.

Trauma

From about three months of age, trauma is the biggest single cause of mortality in ostriches. Lacerations, fractures, and dislocations of leg joints or wings are often the result of incorrect handling (such as holding the birds by the wings), incorrect paddock and fencing design, incorrect transport or shipment, or frequent disturbance of the birds.

Spread legs

Spread legs in young ostrich chicks (particularly during the first week of age) seem to be related to incubation condition, but other factors such as the floor surface of the hatching boxes or the floor and litter in the brooding area may have a causative effect.

Hypothermia

Ostrich chicks raised without foster parents need optimum conditions (see Chapter 6). Low temperatures for long periods may cause hypothermia, stunting and death of chicks.

In some cases it may induce chronic problems characterized by heart failure, hydropericardium and ascites.

Intestinal torsion

Although this problem is seen in individual birds within a flock, it can be severe enough to cause 25 percent mortality. The underlying cause of the problem appears to be related to a drastic change in diet from pelleted concentrated food to a diet based primarily on chopped leaves.

Parsley-induced photosensitivity

Clinical and pathological changes suggesting an acute case of photosensitivity have been reported in ostriches and are caused by the ingestion of parsley (*Petroselinum sativum*). The clinical signs observed in ostriches resemble those described in cases of photosensitization in avian species. In young ostriches, lesions develop around the eyes, face and ears, while in adults the skin of the legs is the most affected part. Chronic lesions consist of scarring of the skin and change of colour from the normal grey to pink in the affected areas of the face and legs.

Leucaena-induced nervous disorder

Feeding certain forages may lead to potential problems. In an FAO-sponsored project in Madagascar (R. D. Branckaert, personal communication), it has recently been observed that feeding Leucaena caused certain types of nervous disorder although the reasons for this are not yet clear.

Chapter 10
Economics of ostrich farming

A number of beef producers in Europe, the United States and Canada have recently switched to raising ostriches commercially because of the higher and faster financial returns of ostrich projects. When compared with traditional livestock, ostriches rate very highly. Whereas a top quality beef cow produces a calf that reaches marketing weight after 645 days from conception, yielding 250 kg meat, an adult ostrich produces no fewer than 40 chicks annually, reaching marketing age after only 407 days from conception (42 days incubation + 365 days to one year of age) and yielding 1 800 kg meat, 50 m^2 leather and 36 kg feathers (see Table 15).

TABLE 15
Comparison between the productivity of cattle and ostriches

	Cattle	Ostriches
Gestation/ incubation period	280 days	42 days
Offspring/year	1	40
Period from conception to slaughter	645 days	407 days
Meat	250 kg	1 800 kg
Leather	2.7 m^2	50.4 m^2
Feathers		36 kg
Maximum breeding age	10-12 years	40 years

As land represents an important constraint in animal production, the comparison is not complete without considering productivity per land unit. Under intensive production systems, ostriches require only one-third of an acre or just over 0.1 ha per breeding trio (six females and three males per acre/0.4 ha), while cows require 1 acre (0.4 ha) each. Converting these figures into productivity per land unit and bearing in mind that ostrich chicks need to be raised separately and hence two extra acres (0.8 ha) will be required, 1 acre (0.4 ha) of land used in ostrich production will yield a minimum of 3 600 kg meat, 100 m^2 leather, and 72 kg feathers, compared with a maximum of 250 kg meat and 2.7 m^2 leather if the land is used for beef cattle.

Furthermore, the net weight of meat represents about 40 percent live weight in ostriches, which is a much higher percentage than that of other farm animals such as cattle, sheep or pigs. In addition, a female ostrich continues this annual production for up to 40 years. Accordingly, with the use of modern husbandry techniques and correct management, the overall production of one female ostrich during her "economic life" can be as much as 72 tonnes meat, 2 000 m^2 leather and 1 450 kg feathers. This rate of production makes ostrich farming an extremely viable and potentially high economic proposition for any country.

INPUTS

The inputs, or costs, that have to be taken into account include fixed inputs (cost of buildings and equipment) and variable or recurring inputs (feed, labour, repairs, fuel and veterinary supplies). Costs of the birds are normally calculated as part of the variable inputs. However, as ostriches live for approximately 70 years, the cost of the birds in the case of ostrich farming is calculated as part of the fixed inputs.

For the project or the enterprise to continue and be successful, the variable costs and part of the fixed costs must be covered by the sale of the offspring and/or eggs every year or every batch. The gross profit is calculated as the difference between the income received from the sale of ostrich products and expenditure on variable costs, while the net profit is the difference between the income received from sales and the sum of both the variable and fixed costs.

Gross profit or margin = Income from sales minus variable costs

Net profit or margin = Income from sales minus (variable costs plus fixed costs)

The depreciation cost should be calculated over ten years for buildings and over six years for equipment. Alternatively it could be calculated for both over eight years. The depreciation cost is then added to the variable costs per bird.

For commercial ostrich projects, the following breakdown of inputs should only be used as a rough guide - costs vary with size of units, country and aim of operation (final product on sale).

Fixed costs (as of 1995)

Cost of birds		
Proven breeders (three to four years)	in US$ per bird	6 000
Cost of buildings		
Breeding and rearing	in US$ per adult bird	2 000
Hatchery	in US$ per egg	80
Cost of equipment		
Fans, brooders, lighting, etc.	in US$ per adult bird	475
Hatchery equipment	in US$ per egg	36
Incubators and hatchers	in US$ per egg	150
Cost of fencing		
140 m fencing per bird	in US$ per bird	140
Cost of slaughter facilities		
Complete slaughter with cooling, freezing and packing *(minimum recommended capacity 50 birds/day)*	in US$ per bird capacity	9 600
Miscellaneous fixed costs	in US$ per adult bird	230

Variable costs (as of 1995)

Feed cost (average price of US$350 per tonne)		
Adults (3 kg/day)	in US$ per bird/year	383
Young (300 kg to 1 year of age)	in US$ per bird/year	105
*Labour cost (*varies with country and location)		
Skilled labour	in US$ per year	....
Unskilled labour	in US$ per year	....
Electricity, veterinary fees and medications		
US$35 per adult/month	in US$ per bird/year	420
Consumables		
US$18 per adult/month	in US$ per bird/year	216
Administration		
US$50 per adult/ month *(including marketing and travel)*	in US$ per bird/year	600

Insurance

For adult birds (*all risks cover*) @ 12 percent	in US$ per year/bird	720

OUTPUTS

The outputs, or sales, that can be achieved from commercial ostrich farming vary with size and location of the project, degree of marketing and whether ostrich products are sold locally or internationally.

Based on international market research, the following is a breakdown of all possible sales involved in commercial ostrich enterprises:

Sale of ostrich eggs

Hatching ostrich eggs	in US$ per egg	75
Empty ostrich eggs	in US$ per egg	5

Sale of live ostriches

Day-old chicks	in US$ per bird	120
Three-month-old chicks	in US$ per bird	220
Six-month-old chicks	in US$ per bird	300
One-year-old birds	in US$ per bird	600

The above prices are based on birds used only for slaughter. In the next few years, particularly once a proper slaughter market has been established, it is expected that the birds will be sold for slaughter according to their live weight (e.g. US$4 per kg live weight).

Sale of ostrich products

Ostrich meat (average)	in US$ per kg	12
Ostrich skin (raw - untanned)	in US$ per skin	250
Ostrich feathers (average)	in US$ per kg	150

FACTORS AFFECTING PROFITABILITY OF OSTRICH FARMS

Many factors influence the degree of profitability (monetary returns) of ostrich operations. Future international market forces may exert pressures on prices of birds and their products. However, the efficiency of production is, without any doubt, the main component or ingredient contributing to the success or failure of the enterprise.

The efficiency of ostrich production can be basically assessed by the following parameters:

Production parameters of adult ostriches

- Number of eggs produced per female per year
- Number of fertile eggs per female per year
- Number of chicks hatched per female per year
- Breeding feed conversion ratio (amount of food consumed per egg or per chick produced, including food consumed by the male and female)

Production parameters of chicks and young ostriches

- Number of chicks surviving to marketing age per female per year
- Marketing age (at present 12-14 months)
- Weight of birds at marketing (their growth rate)
- Growing feed conversion ratio (food consumed per kg live weight)

Production parameters of ostrich abattoirs

(if slaughter and processing are part of the ostrich operation)

- Feather and skin quality
- Meat quality (affected by evisceration and cooling of the carcass)
- Meat yield per bird (affected by deboning procedure)
- Quality of meat cuts and processing

Figure 62 shows a chronological chart of main operations (breeding, hatching and growing) over a five-year period.

The chart is based upon a constant period of breeding of six months each year. The capital letters at the top of the chart refer to the seasons (spring, summer, autumn and winter). It is clear that the first birds will be ready for sale (or slaughter) 58-59 weeks after the onset of the first breeding season (i.e. by the middle of spring the following year). Return on the capital invested should be calculated from that time onwards. Slaughter of birds produced during the first season will continue until the middle of autumn in the second year. This pattern is repeated in subsequent years with the exception that seven weeks from the onset of the breeding season, two groups of juveniles or chicks will be present simultaneously on the farm (those produced early in the current season in addition to those produced late in the preceding season). Adequate facilities are therefore required for raising the different age groups. Furthermore, supplementary lighting will be needed for birds to maximize profitability, particularly those hatching in late spring to early autumn.

FIGURE 62
Ostrich farm operations chart (a five-year scheme)

FIGURE 62
Ostrich farm operations chart (a 5-year scheme)

```
S          S          A          W          S          S          A          W          S

     Breeding (1)                                       Breeding (2)
oooooooooooooooooooooooooooooo..............................oooooooooooooooooooooooooooooo..............................
          Hatching (1)                                        Hatching (2)
     HHHHHHHHHHHHHHHHHHHHHHHH                            HHHHHHHHHHHHHHHHHHHHHHHH
                          Growing (1)
     GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG
                                                                        Growing (2)
                                                         GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG

Growing (2) cont.
GGGGGGGGGGGGGGGGGGGGGGGG
     Breeding (3)                                       Breeding (4)
oooooooooooooooooooooooooooooo..............................oooooooooooooooooooooooooooooo..............................
          Hatching (3)                                        Hatching (4)
     HHHHHHHHHHHHHHHHHHHHHHHH                            HHHHHHHHHHHHHHHHHHHHHHHH
                               Growing (3)
     GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG
                                                                        Growing (4)
                                                         GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG

Growing (4) cont.
GGGGGGGGGGGGGGGGGGGGGGGG
     Breeding (5)
oooooooooooooooooooooooooooooo..............................
          Hatching (5)
     HHHHHHHHHHHHHHHHHHHHHHHH
                               Growing (5)
     GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG
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THE WORLD OSTRICH MEAT MARKET

The global and European market

The global market for ostrich meat is grossly underrated. Nutritionally, ostrich meat has all the properties to ensure a considerable share of the market now held by other meats, particularly beef. From a global standpoint, the total size of the market will depend on whether ostrich is able to make the transition from an expensive exotic novelty meat to a meat that is purchased on a regular basis by a significant proportion of the population. This will obviously depend on the quality of marketing and the worldwide supply of ostriches for slaughter. At present, lucrative markets exist for breeding birds and stock for slaughter may be in short supply. However, with world production of ostriches moving ahead, breeder markets are drying up and most of the leading producers are concentrating on producing birds for slaughter in the future.

When assessing the global and European market, it should be remembered that ostrich meat is an entirely new concept. It is many years since a meat with such unique properties broke on to the world market and it is misleading, therefore, to compare it with the increase in consumption of any other product. It is possible, nonetheless, to draw upon information regarding the uptake of other exotic meats and also consider some of the properties of ostrich meat that are common to other non-exotic products such as chicken and beef. Trends in eating patterns also need to be studied, and how these are emerging or changing in the developing economies.

In order to understand the potential market for ostrich meat, the potential buying countries must first be identified. An assessment can then be made as to the place that ostrich meat might have in the meat market of that country, its potential share and the public perception of ostrich meat in that part of the world.

The European Union market

At first glance, the European Union (EU) countries offer the best potential for the export of ostrich. They have large populations and the type of eating patterns that suggest that ostrich meat will be accepted. When the statistics are compared with other exotic meats such as venison, it may be assumed that, in terms of imports, ostrich meat should be able to capture at least 0.1 percent of the total beef import market. However, in many EU countries, the home production of ostrich meat is poorly developed so that imports from other EU countries or from third countries should be able to secure a 0.1 percent of the total home produced beef market. By combining these two figures it is possible to arrive at a figure for the likely total consumption of ostrich meat. Based on a recent survey of the ostrich meat market by the Executive Agency of the United Kingdom Ministry of Agriculture, Fisheries and Food (ADAS), the potential consumption of ostrich meat for the whole of the EU is estimated to be about 8 881 tonnes per year. This figure assumes that the meat will rise above novelty value but in the short term, i.e. over ten years, that it will not significantly replace beef or any other meat as a staple food item. It does, however, assume some level of home ostrich production.

In terms of market trends, poultry has been able to capture a considerable share of the beef market in most EU states. In general terms, poultry has increased its market share from 22 to 32 percent of per caput meat consumption over the past ten years. Ostrich meat has many of the attributes of poultry meat, but it is unlikely to compete on price. It thus follows that, first, ostrich meat is unlikely to secure much of the poultry market share and, second, the rate of growth at the expense of the beef market share is likely to be much slower. This means that the market for ostrich meat in the EU is likely to grow from the current 8 881 tonnes to about 11 367 tonnes per year in about five years. In the short term, most of this market should be available unchallenged to third countries; in the forefront will be the countries of southern Africa. In the long term, the ostrich market is likely to expand further but more slowly.

The EU can be divided into a number of categories on the basis of ostrich consumption - first, those countries that already consume ostrich meat on a certain scale, such as France and Belgium and, to a lesser extent, Italy and the Netherlands; second, those countries where the ostrich market has not developed at all, i.e. Spain, Portugal, Greece and Turkey; and, finally, those countries where a potential market exists but there are difficulties with the import of ostrich meat because of animal or public health objections or non-compliance of abattoirs with hygiene regulations, for example, the United Kingdom, Germany, Denmark and Ireland.

With regard to the major potential consumer countries of the EU, consumption of ostrich meat in the medium term is estimated to be as follows:

Belgium	212 tonnes
Denmark	107 tonnes
France	3 608 tonnes
Germany	1 686 tonnes
Ireland	35 tonnes
Italy	1 787 tonnes
Netherlands	317 tonnes
United Kingdom	1 129 tonnes

Other EU countries may import small quantities of ostrich meat, but they are not of major importance.

Apart from Switzerland (340 tonnes per annum), other non-EU countries interested in ostrich meat include Finland (100 tonnes), Norway (78 tonnes), Sweden (150 tonnes) and Austria (160 tonnes).

The United States market

The United States is likely to be the largest single market for ostrich meat in the world. First estimates put the short-term market in excess of 15 000 tonnes per year. When the market develops in the United States, this volume could increase considerably.

The Far East market

Far Eastern markets should be taken into consideration, particularly Japan, China (Hong Kong, Special Administrative Region) and Singapore. Markets in the Far East represent a good long-term prospect for the export of ostrich meat. Demand for beef in the Asian markets has expanded rapidly in the last few years, at times over 19 percent per annum. Demand is expected to rise further in the short to medium term, driven by economic growth and a growing consumer preference for beef-style products in the area. All these facts bode well for the future of the ostrich meat market in Asia. Ostrich meat can be used for all the same dishes as beef, and the consumption of exotic meats is well accepted in Asia. Ostrich meat is already exported to Hong Kong, but this at present only represents a fraction of the potential market.

In terms of volume, the following estimates have been made by ADAS of the medium-term market for ostrich meat in the countries with most potential:

Japan	1 190 tonnes
Republic of Korea	290 tonnes
China, Hong Kong SAR	181 tonnes

Market development in the Far East is likely to be more rapid than in Europe, but will probably not develop to the same extent. Furthermore, competition in these markets is not likely to be internal but will almost certainly come in the future from China and Australia.

The Near East market

The Near East can offer a small but potentially lucrative market providing that religious slaughter techniques can be adopted. The potential market is estimated to be 285 tonnes in the short to medium term.

PRICING OF OSTRICH PRODUCTS

Ostrich meat

The price of ostrich meat is currently floating on the world market in an attempt to find a sensible pricing structure. It is only over the past few years that the product has been traded in any volume; even now it is so scarce compared to demand that any established pricing structure is impossible to predict or sustain.

Since competition is almost non-existent, it is really a question of pricing the product at a level the buyer is prepared to pay. This price will vary depending on the location in the world and the type of meat cut offered. At present, most of the meat traded is in the form of chilled and vacuum-packed fillets. The price of ostrich fillet varies as to whether it is FOB or CIF and also whether it is sold direct to the wholesaler or retailer. The 1997 world average FOB price of vacuum-packed ostrich meat was US$15 per kg. This was primarily for sale on the Far Eastern market. For the European market, the price was slightly higher at US$17 per kg.

The above figures are market averages; some prices have been quoted at a lower rate but the FOB price rose to US$23 per kg in some circumstances. These prices are set against the background of an enormous shortfall in demand. For example, the 1997 average retail price of ostrich fillets was around US$36 per kg; this further increased sharply in catering establishments.

The 1997 average wholesale price was around US$24 per kg. Large retailers aimed for at least a 150 percent markup on wholesale prices, thus pushing the average retail price to around US$36 per kg. Many small retailers were possibly aiming for markups in excess of 150 percent, so that retail prices may well have been higher under some circumstances.

The international price of other cuts of ostrich meat is even less predictable. What is referred to in Europe as "steak" rather than fillet is a slightly lower quality, but is still a whole product. The FOB value of ostrich steak was about US$13 per kg, with a wholesale price of US$19 and a retail price of US$31 per kg.

Ostrich skin

Unlike ostrich meat, ostrich hide has a strong and well-developed pricing structure. The 1997 international FOB price of raw hide rose from US$16 to US$27.50 per square foot (0.09 m^2). An average hide of 14 square feet was marketed at US$385 per skin and good quality tanned ostrich skins at around US$45 per square foot.

Again, the demand for ostrich skin outweighs supply, with the result that the above pricing structure is expected to be sustained well into the next century.

Ostrich feathers

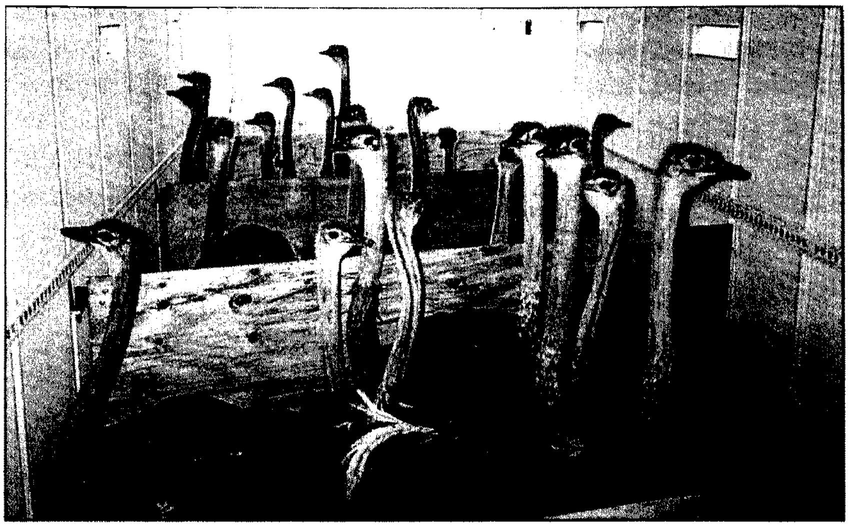
The demand for ostrich feathers is not so great as it was 20-30 years ago. Current prices of feathers vary with quality and position of feathers on the body. Top prices for wing feathers in 1997 were FOB US$250 per kg while tail feathers commanded an FOB price of US$25 per kg. Ostrich feathers are therefore considered to be a secondary product of ostrich production.

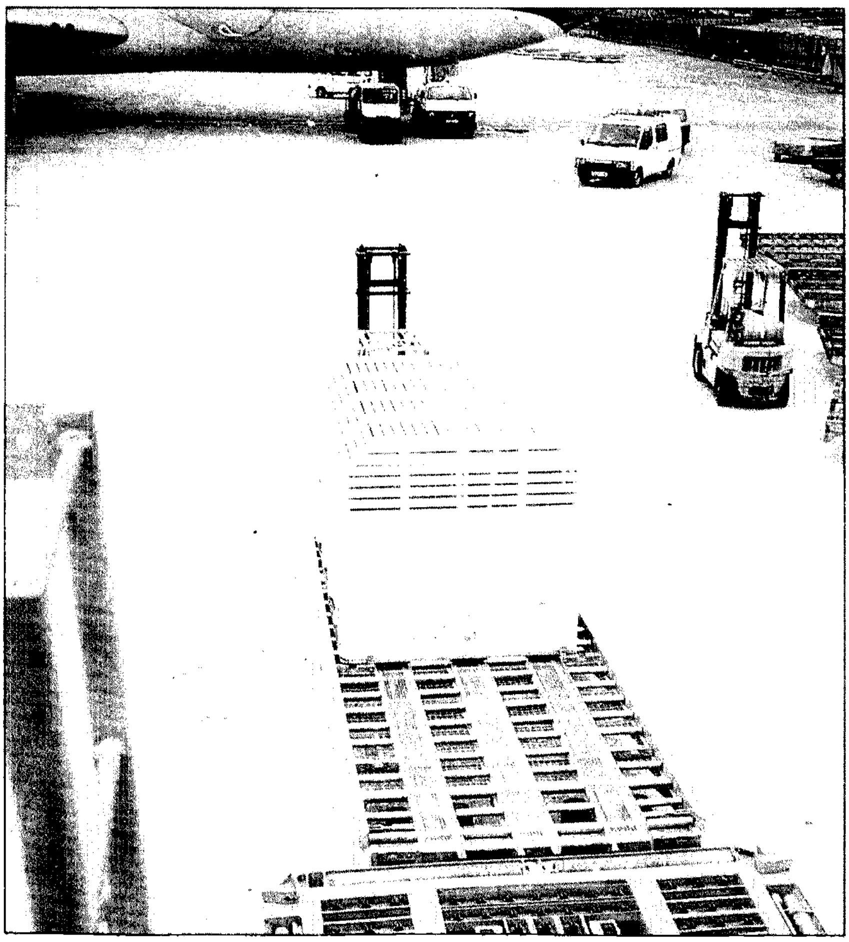
FUTURE OF THE OSTRICH INDUSTRY

Today's commercialization of the ostrich is analogous to the early steps taken by the turkey industry back in the 1920s. In those days, turkeys were quite rare, difficult to find and extremely expensive - some were sold for breeding for as much as US$2 000. By the mid-1960s there were more than 150 million turkeys in production worldwide.

Currently, the ostrich industry in Europe and America is still in the breeding phase, with little commercial processing taking place. Ostriches are sold to other farmers and ranchers entering the ostrich business (Figure 63). Prices are artificially high. However, as ostrich numbers approach high levels to support a slaughter market, prices are bound to drop. In 1992, over 150 000 ostriches were slaughtered worldwide, of which 95 percent were processed in South Africa. At present, there is no concrete estimate as to when the ostrich population will be at a sufficient level to meet current, let alone future, consumer demand.

FIGURE 63
Worldwide air transport of ostriches





In the last few years, ostrich farming has progressed dramatically and the world ostrich industry has achieved some economic stability. On many farms, however, management of birds, particularly young chicks, is still relatively primitive. Furthermore, there is considerable scope for improvement in the areas of artificial incubation, chick nutrition, environmental requirements and selective breeding. Unfortunately, despite its great potential, the ostrich has received and continues to receive little attention from scientists. One of the possible ways of attracting scientific interest and securing proper recognition of the ostrich's versatility, is to hold international symposia and conferences. If ostrich production is to provide the meat of the future, a scientific approach is the only way forward.

Appendixes

APPENDIX 1. **Haematological blood parameters of clinically normal ostriches**

Parameter	Unit	Source* 1 Juveniles	Source* 1 Adults	Source* 2 Juveniles	Source* 2 Adults
Packed cell volume	l/l	0.37	0.40	......	......
Erythrocytes (TRBC)	10^{12}/l	2.10	1.50	1.91	2.42
Haemoglobin	g/l	127	138	133	156
Mean corpuscular volume (MCV)	μm^3	164	193	197	201
MC haemoglobin (MCH)	pg	57	71	71	65.3
MCH concentration (MCHC)	g/l	35	37	36	33
Leucocytes (TWBC)	10^9/l	7.5	5.2	1.9	2.1
Lymphocyte	%	35.4	27.1	......	......
Heterophil	%	60.9	63.6	......	......
Monocyte	%	3.3	1.9	......	......
Eosinophil	%	0.2	0.1	......	......
Basophil	%	0.1	0.1	......	......
Haematocrit	%	.....	......	37.0	48.0
Erythrocyte sedimentation rate	mm/h	1.8	1.4	......	....
Erythrocytes					
Cell length	µm	.....	.....	13.2	13.3
Cell width	µm	.....	.....	7.49	7.53
Nucleus length	µm	.....	.....	5.47	5.58
Nucleus width	µm	.....	.....	2.89	2.96

**Source*: 1 Levy *et al.*, 1989b
2 Palomeque, Pinto & Viscor, 1991

APPENDIX 2. **Chemical blood parameters of clinically normal ostriches**

Parameter		Source*			
	Unit**	1	2	3	4 (in serum)
Total protein	g/l	38.7	37	40.4	38.0
Glucose	mmol/l	2074 mg/l	13.9	9.7	2 450
mg/l					
Triglycerides	mmol/l	....	1.2	....	1 300
mg/l					
Urea	µmol/l	23.4 mg/l	0.4	0.49	....
Uric acid	mg/l	111.7	487 µmol/l	....	91
Cholesterol	mg/l	1162	2.8 mmol/l	....	1 000
Bilirubin	mg/l	1.44	5.8 µmol/l	....	....
Creatine	µmol/l	6.4 mg/l	28	36.6	40 mg/l
Lactate dehydrogenase	IU/l	515	1565	1041	734
Alkaline phosphatase	IU/l	172	575	479	150
Alanine transaminase	IU/l	20.62	2.0	2.9	20
Aspartate transaminase	IU/l	190.5	131	237	280
Creatine kinase	IU/l	933.0	688	1589	2 470
ϒ-glutamyltransferase	IU/l	......	1.5	0.5	2.1
Albumin	g/l	......	.....	20.0	18.0
Na^+	mmol/l	3.69 g/l	147	151	......
K^+	mmol/l	66.4 mg/l	3.0	3.5	......
Cl^-	mmol/l	312.9 mg/l	100	104	......
Ca^{2+}	mmol/l	180.7 mg/l	2.3	2.5	95.0
mg/l					
PO_4	mmol/l	137.1 mg/l	1.6	1.7	52.0
mg/l					
Mg^{2+}	mmol/l	22.4 mg/l	1.1	0.8	......

* *Source*: 1 Palomeque, Pinto & Viscor, 1991
2 Levy *et al.*, 1989b
3 Van Heerden *et al.*, 1985
4 Okotie-Eboh *et al.*, 1992

** Units of measurement unless shown after individual values

APPENDIX 3. **Examples of some commercial ostrich diets**

COUNTRYSIDE

OSTRICH GROWER FEED

ANALYSIS

Oil	5.00%
Protein	16.00%
Fibre	10.50%
Calcium	0.95%
Phosphorous	0.77%
Salt	0.32%
True Dig. Lysine	0.88%
True Dig.Methionine	0.32%
True Dig.Tryptophan	0.18%
True Dig.Threonine	0.50%
Starch	32.25%
Vitamin A	12000iu/kg
Vitamin D3	5000iu/kg
Vitamin E	300iu/kg
Selenium	300mg/kg
Copper	10mg/kg

INGREDIENTS

Barley, Sunflower extractions, Hipro Soya, Grassmeal, Vegetable Oil, Dicalcium Phosphate, Limestone, Salt, Clark & Butcher special premix pack for Ostriches

FEEDING INSTRUCTIONS

Feeding period: 5 months to 1 year of age

* For the first week mix some Rearer feed with the Grower feed. Reduce the amount of Rearer gradually so that by the end of the week the chicks are offered all Grower feed.
* From 5-6 months of age allow 1.4-1.6kg per bird per day
* From 6-9 months of age allow 1.8-2.0kg per bird per day
* From 9 months onwards allow 2.0kg per bird per day

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COUNTRYSIDE

OSTRICH MAINTENANCE FEED

ANALYSIS

Oil	3.00%
Protein	16.00%
Fibre	14.50%
Calcium	0.70%
Phosphorous	0.58%
Salt	0.30%
True Dig. Lysine	0.58%
True Dig.Methionine	0.26%
True Dig.Tryptophan	0.18%
True Dig.Threonine	0.52%
Starch	21.95%
Vitamin A	12000iu/kg
Vitamin D3	5000iu/kg
Vitamin E	300iu/kg
Selenium	300mg/kg
Copper	10mg/kg

INGREDIENTS

Barley, Grassmeal, Sunflower extractions, Wheatfeed, Dicalcium Phosphate, Limestone, Salt, Clark & Butcher special premix pack for Ostriches

FEEDING INSTRUCTIONS

Feeding period: from 1 year of age and out of breeding

* For the first week mix some Grower feed with the Maintenance feed. Reduce the amount of Grower gradually so that by the end of the week the chicks are offered all Maintenance feed.
* For adult birds there is no need for a gradual change of feed.
* For yearlings allow 2.0kg per bird per day.
* Change to Breeder feed at 18 months of age.
* From adult birds not in breeding allow 2.0kg per bird per day

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COUNTRYSIDE

OSTRICH BREEDER FEED

ANALYSIS

Oil	6.00%
Protein	16.50%
Fibre	7.00%
Calcium	4.50%
Phosphorous	0.68%
Salt	0.38%
True Dig. Lysine	0.64%
True Dig.Methionine	0.28%
True Dig.Tryptophan	0.18%
True Dig.Threonine	0.51%
Starch	31.61%
Vitamin A	12000iu/kg
Vitamin D3	5000iu/kg
Vitamin E	300iu/kg
Selenium	300mg/kg
Copper	10mg/kg

INGREDIENTS

Wheat, Sunflower extractions, Full Fat Soya, Limestone, Vegetable Oil, Fishmeal, Grassmeal, Dicalcium Phosphate, Salt, Clark & Butcher special premix pack for Ostriches

FEEDING INSTRUCTIONS

Feeding period: from 18 months of age and during breeding

* There is no need for a gradual change of feed to Breeder
* From 18 months of age and during the breeding season allow 2.5-3.0kg per bird per day
* Place feed in containers at several locations near the fence to minimise disturbance to the birds

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COUNTRYSIDE

OSTRICH GROWER BALANCER FEED

ANALYSIS

Oil	6.00%
Protein	23.00%
Fibre	15.00%
Calcium	1.80%
Phosphorous	1.21%
Salt	0.41%
True Dig. Lysine	1.36%
True Dig.Methionine	0.52%
True Dig.Tryptophan	0.25%
True Dig.Threonine	0.73%
Starch	11.05%
Vitamin A	12000iu/kg
Vitamin D3	5000iu/kg
Vitamin E	300iu/kg
Selenium	300mg/kg
Copper	10mg/kg

INGREDIENTS

Sunflower extractions, Barley, Grassmeal, Hipro Soya, Full Fat Soya, Dicalcium Phosphate, Vegetable Oil, Limestone, Salt, Clark & Butcher special premix pack for Ostriches

FEEDING INSTRUCTIONS

Feeding period: from 5-12 months of age

The Balancer feed is manufactured in a 3.2mm pellet for easy mixing with whole grain barley. The pellet size helps to avoid selective feeding. Mix equal quantities of the Balancer feed with Barley and feed the mixture ad-libitum up to 1.5kg per bird per day to 9 months of age and up to 2.0kg per bird per day from 9 to 12 months of age.

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COUNTRYSIDE

OSTRICH REARER FEED

ANALYSIS

Oil	3.00%
Protein	18.00%
Fibre	8.00%
Calcium	1.05%
Phosphorous	0.90%
Salt	0.40%
True Dig. Lysine	0.97%
True Dig.Methionine	0.35%
True Dig.Tryptophan	0.20%
True Dig.Threonine	0.56%
Starch	34.00%
Vitamin A	12000iu/kg
Vitamin D3	5000iu/kg
Vitamin E	300iu/kg
Selenium	300mg/kg
Copper	10mg/kg

INGREDIENTS

Barley, Wheat, Sunflower extractions, Wheatfeed, Hipro Soya, Grassmeal, Full Fat Soya, Dicalcium Phosphate, Limestone, Salt, Clark & Butcher special premix pack for Ostriches

FEEDING INSTRUCTIONS

Feeding period: 5 weeks to 5 months of age

* For the first week mix some Starter feed with the Rearer feed. Reduce the amount of Starter gradually so that by the end of the week the chicks are offered all Rearer feed.
* From 5-9 weeks of age allow 300-450g per chick per day
* From 10-16 weeks of age allow 700-1000g per chick per day
* From 16-20 weeks of age allow 1.2-1.4kg per bird per day

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COUNTRYSIDE

OSTRICH STARTER FEED

ANALYSIS

Oil	3.25%
Protein	23.50%
Fibre	5.00%
Calcium	1.35%
Phosphorous	1.02%
Salt	0.40%
True Dig. Lysine	1.28%
True Dig.Methionine	0.46%
True Dig.Tryptophan	0.26%
True Dig.Threonine	0.79%
Starch	27.50%
Vitamin A	12000iu/kg
Vitamin D3	5000iu/kg
Vitamin E	300iu/kg
Selenium	300mg/kg
Copper	10mg/kg

INGREDIENTS

Hipro Soya, Wheat, Barley, Grassmeal, Wheatfeed, Fishmeal, Sunflower extractions, Dicalcium Phosphate, Limestone, Salt, Clark & Butcher special premix pack for Ostriches

FEEDING INSTRUCTIONS

Feeding period: hatching to 5 weeks of age

* Do not feed ostrich chicks for the first day after hatching
* From 2-7 days offer the Starter in wet form ad-libitum
* Place a few drops of clean water on feed and mix thoroughly. Leave for 5 minutes then offer to chicks. Discard any left-over feed.
* From 8 days offer the feed as it is in dry form ad-libitum

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OSTRICH PRODUCTION SYSTEMS

Part II - Case studies

by

John Dingle

FAO Visiting Scientist
September - December 1996

Introduction

Ostriches originated in Africa and were taken in the late 1800s and more recently, in the 1990s, to Europe, the Middle East, Asia, Australia and the Americas. Originally the product of interest was the ostrich feather, but nowadays the leather is the most valuable product. The ostrich industry in all these countries utilises the existing sub-species of the native ostrich as the basis of their breeding stock. The four sub-species are the:

- North African Red-neck (*Struthio camelus camelus*);
- East African Blue-neck (*S.c. molybdophanes*);
- East African Red-neck (*S.c. massaicus*); and
- South African Blue-neck (*S.c. australis*).

Foundation stock have been captured or hatched from the wild and in many cases cross-bred, although not all the subspecies interbreed. The commonest cross is the South African Black-neck which contains genes from the North African Red-neck, South African Blue-neck and also from the now extinct Arabian subspecies (*S.c. syriacus*).

The structure and stage of development of the ostrich industry in 1996 in the Republic of South Africa, Namibia, Zimbabwe, Kenya, Ethiopia, the United Arab Emirates and Australia is presented in a series of case studies as Part II of this manual. The size and relative importance of the ostrich industries in the African countries surveyed is summarized in Table 1.

TABLE 1
Number of adult female breeders, total ostriches and farms in African countries in June 1996

Country	Female Breeder Ostriches	Total Ostriches	Number of Ostrich Farms
South Africa	30 000	300 000	400-450
Namibia	5 000	43 000	100+
Zimbabwe	3 000	30 000	240
Kenya	[250]	2 500	30
Ethiopia	35	45	1
Total	38 285	375 545	770-820+

Source. Van Zyl 1996, and others

Chapter 1
South Africa

BACKGROUND

South Africa is a country 2 000 km x 1 500 km in size at the foot of Africa with a population of 42 million. The Tropic of Capricorn runs just north of the country so it has a sub-tropical to temperate climate. The Drakensberg range of mountains runs about 130 km inside the eastern and southern coastline. The interior of the country is a reasonably flat plateau about 300 m above sea level, bordered by the higher Drakensberg range, but towards the coast the land steps down in a series of smaller plateaux. In the south, at a height of about 150 m, the Klein (Little) Karoo is one such steppe lying between the Drakensberg to the north and the Quinzenburg range to the south.

The Klein Karoo region, the main ostrich producing area in the world, is approximately 21 000 km^2; however the majority of ostrich farms are within a 100 km radius of the central town Oudtshoorn. The rainfall here is low, about 500-600 mm per year, but the area is watered by rivers fed by melting snows from the peaks of the Drakenbergs. Irrigation is possible in many places, but water rights have to be purchased.

Four Acts of Parliament gave Klein Karoo Cooperative monopoly control from 1870 to 1993. Three of these Acts have been rescinded, but the Livestock Improvement Act still prohibits the export or import of live birds and fertile eggs. Opinion is divided in South Africa as to whether or not to support the lifting of this ban. A number of South African ostrich farmers established farms in Namibia during the 1990s to enable them to supply the international market with live ostriches.

THE HISTORY OF OSTRICH FARMING IN SOUTH AFRICA

The history of ostrich farming in South Africa can be divided into five periods:

- **1863-1913**: Expansion of ostrich numbers in the Eastern Cape and the Klein Karoo from just 80 in 1865 to one million by 1914. The industry was based on feather production for fashion accessories, and North African Red-neck (*Struthio camelus. camelus*) ostriches were imported in 1877 to improve feather quality of the native South African Blue-neck (*S.c. australis*) thus producing the local South African Black-neck strain (*S.c. domesticus*).
- **1914-1945**: Contraction of ostrich numbers from one million to 23 000 in 1930.
- **1946-1973**: Revival in Klein Karoo and the establishment of the Klein Karoo Landboukooperasie, (KKLK) with the emphasis still on feather sales and with an annual return of five million rand (Rand 3.5 = US $1)

- **1974-1993**: Development of meat and leather markets valued at seven million Rand while the feather market declined to three million Rand. Expansion into other areas of South Africa and the establishment of other farmer organisations but with KKLK retaining the core marketing functions.
- **1994-1996**: Deregulation of the industry, establishment of abattoirs and tanneries in Eastern Cape (Graff Reinet, Grahamstown and Port Elizabeth) and the establishment of national associations: the Ostrich Breeders' Society of South Africa, the South African Ostrich Producers Association and the South African Ostrich Processors Association were all formed in 1994.

CURRENT STATUS OF THE OSTRICH INDUSTRY [1/]

In the Klein Karoo, the ostrich industry remains well established. The Klein Karoo Cooperative processes birds and prepares and sells leather, meat and feathers which provide respectively, 70 percent, 25 percent and 5 percent of the farmers' return. The KKLK now has agents in Europe and Asia to market their products.

In the Eastern Cape and the Transvaal, the industry is now also well established. New abattoirs have been built or old ones converted, and the flow of birds for slaughter has been organized. New markets such as the European Union have been investigated and delegations from individual European countries have inspected South African export slaughter facilities and procedures.

In 1995, about 170 000 birds were slaughtered in South Africa. This is 85 percent of the world total and about 75 percent of these were from the Klein Karoo area. The capacity of the largest ostrich abattoir in Oudtshoorn is twice this amount and can process 360 000 birds per year. There are six European Union approved ostrich abattoirs, five tanneries and six meat processing plants in South Africa. The distribution of birds in the three main producing areas is given in Table 2.

TABLE 2
Distribution of ostriches in the main producing areas

Area	Total number of ostriches	Breeding females
Oudtshoorn Area	200 000 - 300 000	15 000
Eastern Cape Area	50 000 - 100 000	5 000 - 7 500
Transvaal and rest of country	50 000 - 100 000	5 000 - 7500
Total	300 000 - 500 000	25 000 - 30 000

[1] 1996

FUTURE DEVELOPMENTS

It is not known what the demand for the South African Black-neck strain will be. While it is the ideal bird for feather production, opinion is divided regarding its qualities for leather and meat production. Over the last five years producers have benefited from the export of live birds to the USA, but the high prices paid for breeding stock have fallen recently, so there is less likelihood of high profits from the sale of breeding stock in the future.

The Agricultural Development Centre at Oudtshoorn has begun a programme to provide information on which to base future decisions. Investigations are being undertaken on incubation temperatures and humidity, the nutritional value of feed stuffs and the value of other ostrich subspecies and crossbreeds compared with South African Black-neck strain. There are opportunities to improve productivity through selection since some 25 percent of layer hens produce 75 percent of the total eggs (Smith *et al*, 1995). Separate lines for the specialized production of meat or leather may also be developed in future. For example, selected birds have produced 38 kg of usable meat with a more acceptable light colour at six to seven months of age with a feed conversion ratio of 4:1. Leather from younger selected ostriches is more suitable for speciality end-products.

Given the reduction in returns following the expansion of ostrich production both inside and outside South Africa, the KKLK have reviewed their purchasing and marketing arrangements. It is likely that changes will be made in the local quota system and in the system of overseas agents.

SUBSPECIES AND STRAINS

The South African Black-neck *(S.c. domesticus)* is virtually the only type of ostrich farmed in South Africa. It is a cross between the Southern African native Blue-neck subspecies *(S.c. australis)* and a special strain of the North African Red-neck subspecies *(S.c. camelus)*. The special strain had double the amount of fluff (barbules) along the ribs (barbs). Some birds from Namibian farms have recently been reintroduced into South Africa and they are reported to have advantages in terms of fertility but are less docile. The Ostrich Research Centre in Oudtshoorn (Klein Karoo Agricultural Development Centre) will be importing some Red-necks from Kenya and Blue-necks from Zimbabwe for comparative production studies. The features of the South African Black-neck compared to the four native subspecies are:

- It is smaller (slaughter weight is 90 kg at 14 months).
- It is more docile.
- It has lower maintenance requirements.
- It produces skins of a size (120 dm^2 or 14 ft^2) and grain (follicles full and closely spaced) at 14 months of age which the market expects and demands.
- The feathers are of high quality.

ENVIRONMENTAL AFFECTS

The climate in Oudtshoorn is dry and warm for most of the year. There are two wet seasons, a short winter rains and a longer, heavier summer rains. This climate is ideal for rearing ostrich chicks which, because their feathers do not have a waterproof oily coat like other birds, suffer chills with subsequent infections should they get wet. Ostriches can also go for long periods without water and can usually obtain enough moisture from the dew on leaves and other food, although they will drink large quantities of water if available. The extremely long colon of the ostrich plays an important role in water reclamation, as well as in the digestion of plant fibre. As a consequence of the climate, the natural vegetation and lucerne pastures remain short and do not present hazards for injuring the birds or their skin.

In the wild, ostriches in South Africa may breed at any time of the year. In the farm situation, however, the breeding season is controlled to last approximately six to nine months. In some areas the breeding season is arranged to run from early winter (May) to late summer (January), while in other areas it runs from autumn (March/April) to spring (September) (Holtzhausen and Kotzé, 1990; Sales and Smith, 1995). After the first clutch of eggs is laid, the female usually rests for some weeks and then lays a second clutch, often triggered by the start of the summer rains in October. If eggs are removed and incubated, the total number of eggs collected may reach a maximum of 80 per bird. The last 15 will be left in the nest for the hen to incubate herself, and to induce the end of lay.

Ostriches will eat berries, fruits, flowers, seeds, leaves and green shoots of the natural vegetation, but not whole plants. The natural food for Karoo ostriches is a mixture of juicy leaves of the vygie (*Mesembryanthenum*), spekboom (*Portulacaria afra*), gannabos (*Salsola aphylla*), and berries and fruit of ghwarrie (*Euclea undulata*), wild plum (*Colpoon compressum*), koeniebos (*Rhus undulata*), and noem-noem (*Carissa haematocarpa*). A need for calcium causes ostriches to eat bones, eggshells and seashells.

The more docile South African Black-neck strain does not injure itself as much as other subspecies. Nevertheless, fences can be a danger when they are panicked by such things as helicopters and motor cycles, or when chasing cars or dogs. If fences are near roads, white plates are hung from the wires to make them more visible to the birds.

MANAGEMENT SYSTEMS

Because of the specialization in the ostrich industry in the Oudtshoorn area, management systems must be classified in a different way from elsewhere in the world.

Only a few farms (5-6) in the Oudtshoorn area care for the ostrich throughout its life cycle. These farms also tend to be 'show farms' open to visitors. A number of farms keep only breeding birds, either in pairs, trios or group matings. Natural incubation and fostering is regularly practised in addition to artificial incubation and brooding. Other farms specialize in keeping birds of particular age groups to slaughter and a farm may have one or more different age groups. Regular auctions allow birds to be purchased at the following ages: day old, 3 days, 3 weeks, 3 months, 6 months, 9-10 months, and 12 months. Birds are sold for slaughter at 14 months.

The main criteria governing the choice of specialization are farm size, area of lucerne and working capital. For example, a breeding farm must have enough area, often with native vegetation, in which to rest the birds between breeding seasons. Holding younger birds for a short time, usually three months, provides a better cash flow. Taking birds on to slaughter involves the risk of their being downgraded and not covering their purchase price. Hence there is pressure to keep the purchase price low for birds to be kept for slaughter and this consequently puts pressure on the price of younger birds.

The availability of lucerne also determines the age class of birds to be kept because of the phase feeding method used in the Oudtshoorn area. Mixed rations are fed to the birds for the first nine months and from three weeks to four months of age lucerne is included in the ration. In addition, lucerne pick is available to the birds at all ages. Phase feeding involves changing rations at around the following ages:

- 0-3 weeks: complete mixed starter ration, containing no lucerne;
- 3-16 weeks: complete mixed ration which includes milled lucerne;
- 4-9 months: grower concentrate containing no lucerne; and
- 9 months to slaughter (14 months): no additional feed provided.

Access to lucerne is provided in the first two phases mainly for exercise and stimulation; whereas in the latter phases it is also to provide essential nutrients. The state of the pasture and the cost of concentrate and mixed feed therefore determine the age group of birds kept and the feeding regime at each age.

BREEDING AND REPRODUCTION

It is common for breeding pairs to be kept in a 0.25 ha paddock containing lucerne that should be sufficient for the whole season and not be denuded. If natural veldt is used then the breeding paddock needs to be between 2-3 ha. Eggs may either be collected for artificial incubation or left in the paddock for natural incubation and rearing of the chicks by the parents. If eggs are to be left in the paddock an artificial nest filled with sand and covered with a simple "A" frame shelter may be provided in the centre of the paddock. A maximum of 25 chicks is allowed per breeding pair and younger chicks may be added to the brood to make up this number.

Many breeding farms have a combined system of allowing a proportion of their breeders to sit on their eggs, while the rest of the eggs are collected and artificially incubated. The resulting chicks are fostered out with the natural broods. The standard stocking rate remains at 25 birds per 0.25 ha paddock, although many farms place up to 80 chicks in the yard if there is adequate shelter. On farms with no foster parents, all eggs are artificially incubated. Hatched chicks may then be sold at one to three days of age or reared and sold between 3-16 weeks. These farms may have more than one female in a breeding group, but the practice is not favoured because of the desire to keep accurate breeding records.

After the first frost in May the females are introduced into the breeding yards in order to become used to the new environment before the male is introduced three or four days later. The same yard is used each year for the same pair of birds. Males mate with the females more than once a day and will build several nests from which the female chooses one in which to lay. Eggs are laid in the afternoon and collected in the morning. A veterinary laboratory commonly conducts semen evaluation of males.

Handling and disturbance of the breeding birds is minimized during the breeding season. When the sexes are separated at the end of January, the following handling and treatments are given:

- full body pluck;
- spraying for lice, ticks and mites (one week after plucking when the feather follicles have sealed);
- treatment for wire-worms at the start and for tapeworms at the end of the rest period;
- vaccination against Newcastle Disease, necrotic enteritis and 'green urine';
- culling of less productive birds below the expected average egg production of ten plus per month; and
- feed intake is controlled to adjust body weight - usually weight reduction is required.

INCUBATION AND HATCHING

Eggs are collected daily, fumigated with formaldehyde and washed or sprayed with a sterilizing solution. Commercial hatcheries often have continuous egg washers, which create less egg rot problems than submersion washers. Eggs are stored on their end for a minimum of seven days at 15-20°C and 75-80 percent relative humidity (RH), and turned once a day.

Eggs are preheated to 25°C for 12 hours prior to incubation and are placed horizontally in the incubator for the first two to three weeks and rolled 180° three times a day. They are then candled to determine the location of the air sac and placed on end at a 45° angle with the air sac upwards and turned 90° hourly up to the 39th day. Incubation temperatures should be about 36°C with an RH of 28-34 percent. Eggs are then placed in hatchers, which may be in separate rooms, on day 39 or 40 and candled frequently to determine the stage of hatch. Hatched chicks are left in the incubator for a day or two to dry and keep warm and navels are disinfected

Most incubators are old wooden designs that cannot be finely adjusted, but there are a few farms with modern incubators. The newer hatcheries have filtered air and positive internal pressure, and monitor carbon dioxide (CO_2) and oxygen (O_2) levels in the incubator. All hatcheries have quarantine procedures limiting staff access, and hygiene procedures, which range from shoe covers and footbaths to complete changing rooms.

Overall, chick production from all eggs laid in the Klein Karoo is about 45 percent and includes eggs not incubated for various reasons. On average, fertility is about 75 percent and hatchability of fertile eggs is about 80 percent. The best farms however, are achieving around 90 percent hatchability of eggs set.

BROODING

Natural Brooding .

Parents with good brooding histories are selected and both sexes share the brooding. Parents and chicks may be separated at different ages. When chicks are four to six weeks old they may be taken away for hand rearing and replaced by day olds. If chicks are older than four to six weeks the parents may not accept young chicks again and will be returned to breeding pens to lay again.

Artificial Brooding.

Initially, brooding rooms confine young chicks in small groups of approximately 50 in enclosures (3 m x 3 m) at a temperature of 26°C which decreases by about 1°C each day. The floor is nonslip and good ventilation is essential. Flat feed trays with mash are scattered around the enclosure and bottle drinkers are placed on the floor.

After two weeks, if the outside temperature is warm enough, the chicks are allowed out to graze lucerne and heaters are turned off during the day to encourage the chicks to go outside. Chicks are kept inside however, in wet, windy or cold conditions. Feed and water may be placed in the yards and shade-cloth attached to the fence to protect from the wind and sun. The grazing area is gradually enlarged, although the height of the lucerne is kept short, and from four weeks the chicks do not need access to shelter.

GROWING TO SLAUGHTER

Birds are often taken off lucerne pasture and their feed intake restricted, from four months to slaughter. During this period density is about 50 birds per 0.5ha. Feed is usually the natural saltbush veldt grazing supplemented with a grain such as maize. The Little Karoo Agricultural Development Centre (LKADC), however, recommends feeding a complete ration and to virtually ignore any natural feed eaten (see section on nutrition). Clean drinking water is available *ad lib*. The high density of birds leads to parasite problems and regular treatments are given. Birds may be rotated around to different 'feedlots' to provide variety and to prevent vices such as feather pecking and eating stones, soil and manure. Chick quills are clipped at six months, mature body plumage is plucked at seven months, quills plucked at eight months and all feathers are ready to harvest again at slaughter.

NUTRITION AND FEEDING

Many farmers pay little attention to nutrition and feed only maize and lucerne as a supplement. This practice has resulted in nutritional deficiencies in the past. After birds are plucked or in cold weather, additional grain (maize up to a maximum of 300 g/day) is fed.

For a complete feeding programme, without taking account of natural vegetation, Table 3 is a compilation of the recommendations of Little Karoo Agricultural Development Centre (LKADC), Cilliers and Van Schalkwyk 1994, and Cilliers 1996. Details of LKADC's amino acids, vitamins and mineral recommendations the are given in Smith et. al. (1995) and Smith (1995).

TABLE 3
Recommended complete rations

Production	Period (mths)	Body Weight (kg)	Chest Circum-ference (cm)	Crude Protein %	TME[a] (MJ/ KgDM)	Grain %	Roughage %
Pre-starter	0 - 2	12	59	23	13	55	0
Starter	2 - 4	12 - 35	84	20	13	50	- 20
Grower	4 - 6	35 - 58	98	16	12	40	50
Finisher	6 - 10	58 - 90	111	14	11	25	70
Slaughter	10 - 14(-20)	90 - 110	119	12	8	0	90
Breeder							
- flushing				14	9	25	70
- breeding				14	9	0	90
- rest				8	6.5	0	90

[a] Total Metabolizable Energy. Vitamin and mineral premixes are added to all rations.

Roughage is fed in the form of lucerne or bran which is included in the ration and taken into account in calculating the crude protein content. The feed efficiency of ostriches falls with age in the following pattern:

Age (months)	Feed Conversion Ratio (feed/gain)
0 - 2	2
2 - 4	2
4 - 6	3.8
6 - 10	5.5
10 - 14	10

The energy efficiency of ostriches increases with age. The ostrich has a large hindgut and uses hemicellulose and cellulose fermentation to provide volatile fatty acids, which are absorbed from the hindgut and used for energy production. After the first month of life they are much more efficient than chickens in this respect. See data below derived from Angel, 1993.

Age	ME value of feed given to ostriches cf. chickens
3 weeks	90 %
6 weeks	120 %
10 weeks	135 %
17 weeks - 30 months	140 %

It has been found that the breeder diet recommended for egg production in female ostriches is inappropriate for males, as they tend to put on weight and risk becoming infertile from an induced zinc deficiency caused by the high calcium levels in the diet. It has been recommended therefore that the males should be kept and fed in a separate pen adjacent to the female, and introduced into female pen for a few hours every second day after the females have eaten.

Many ostrich producers add some or all of the following supplements to their pre-starter and starter diets:

- electrolytes to prevent dehydration;
- acidification substances to compensate for low acid production in the proventriculus of young birds;
- amylase, protease and cellulase enzymes to increase the efficiency of digestion of starch, protein and fibre;
- additional manganese and zinc supplements to prevent slipped tendon and bent legs; and
- additional selenium and vitamin E supplements to prevent "white muscle disease".

FACILITIES AND HANDLING

Facilities

Fences are made of hedges or post and wire at least 1.5 m high. Wire fences are made of four or five strands of smooth No. 8 gauge wire. Paddocks are separated by 2-5 m and planted with a hedge of prickly pear, Agave (American aloe) or other trees so that birds do not see each other and become excited. The vegetation also acts as a fodder bank for use during drought. Fences near roads have white strips inserted to make them more visible to ostriches running along the fence beside a vehicle.

To keep eggs dry covered nests filled with sand are provided.. The shelter, an 'A' frame structure of wooden poles 3 x 3 x 3 m, has the open ends facing north-south. Sheds are used for housing chicks up to a few months of age and for the protection of all birds during rain or cold weather. The plucking box is often attached to the outside wall of the shed under an extension of the roof. Other sheds or buildings are used as incubator rooms. Few farms have purpose built hatcheries.

Handling

Ostriches are handled in solid walled structures otherwise they will try to escape through or over fences. A 'kraal' is a 2.5 m high walled enclosure traditionally made of clay or stone, but modern structures may consist of plyboard on a post or metal framework. A plucking box is a triangular crush 0.5 m wide in front, 0.75 m wide at the rear, 1.3 m high and 1.3 m long, lined with timber. The bird is pushed into the front of the crush and held firmly by placing a crossbar under the abdomen to prevent it reversing. A rope or strap is tied over the back and under the wings to prevent the bird jumping out.

All birds are herded together into a corner of the kraal or shed and maybe caught with a hooked stick or crook about 3 m long with a loop about 6 cm wide which fits around the neck but cannot slip off the head. One bird is hooked under the head with the crook and the head pulled down, while three assistants control the bird by holding the tail and each wing. A hood pulled over the bird's head makes it docile. Birds are dosed after pulling the beak out of a corner of the hood.

Younger birds can be caught by hand around the neck just under the head. The other hand is used to hold the lower jaw with the thumb pressing down inside the mouth and the fingers pressing up below the jaw. The bird's head is held low by stretching the arm down full length while standing back to avoid being struck by the feet. Birds get used to handlers in the same clothing but may be disturbed by a handler in different clothes (Smith, 1963).

SLAUGHTER AND PROCESSING

In 1995, approximately 200 000 birds were slaughtered in South Africa and approximately 20 000 birds elsewhere, so that international competition was not greatly affecting South Africa's markets at the time.

Birds are traditionally plucked prior to slaughter although shearing is now being advocated. They are killed by electric stunning then hung by the hocks to bleed. The skin is removed using two cut lines. One is a mid-ventral cut and the other is at right angles along the median thigh and then down the front of the lower leg. The birds are then eviscerated and the liver, heart and gizzard separated.

PRODUCTS

Meat

Originally all meat was dried and sold as 'biltong'. Now selected muscles are sold as fillet (5-10 kg) and steak (10-15 kg) and the rest of the meat (10 kg) dried as biltong or used in wurst (sausage) manufacture. The designation of 'fillet' and 'steak' is not based on objective tests of meat quality and only in recent years has objective testing of ostrich muscle been undertaken (see Mellett 1985, 1994, 1995). These show that all muscles of a 14 month old ostrich are of acceptable tenderness compared with beef.

After slaughter the carcasses are chilled and the meat boned out the following day. Rigor mortis is rapid, so cold shortening and electrical stimulation do not appear to affect ostrich meat and hot deboning is not likely to affect quality (Mellet, 1985; Sales, 1994). The final pH of the meat has been reported to be 5.6-6.0 and indicates that birds may be stressed prior to slaughter since normal pH in muscle is around 5.5. Conditioning or maturing has been shown to have little effect on ostrich meat. Vacuum packaging should allow natural meat enzymes to tenderize the meat but this has yet to be measured. The relatively high pH of ostrich meat means that:

- it is at risk of more rapid growth of surface bacteria and thus has a shorter shelf life (although vacuum packaging normally destroys such bacteria);
- there is better water retention thus making for better processing meat with less requirement for phosphates; and
- easily fermented carbohydrates (dextrose is recommended) need to be added to salamis along with lactobacilli and micrococci (*L. curvatus* and *Micrococcus* are recommended).

Other South African ostrich meat products include: liver spread (paté); necks which are sold and prepared like oxtail; gizzards which are cured and smoked like ox tongue, and hearts, used in the same way as hearts of other animals.

Skin and Leather

The KKLK standards for ostrich skins are:

- Size — 120 cm^2 (14 ft^2)
- Grade A — Free from sunburn, scars and lacerations in each quadrant of the back follicle area
- Grain — Follicles of average size and hemispherical
- Strength — Sufficient to stretch over a boot-tree without tearing

Slaughter age (14 months) and weight (90 kg) have been set to produce skins of the required standard although the skin may reach 120 cm^2 by the time the bird reaches 73 kg live weight at 10 months of age. Leather strength is related to skin thickness which is related to age. Optimum recommended thickness for various end products is:

- clothing: 0.85 mm
- handbags and boots: 1.25 mm
- belts 1.45 mm (thicker skins from cull birds)

Feather follicle shape is also related to age and feather maturity. If feathers are "green" and not easily plucked, they tend to pull the follicle out and stretch the skin, resulting in a cylinder of skin projecting above the surface of each follicle. On the other hand the feathers should not be too ripe, as the entrance to the follicle may be left hollow and not plugged with follicle tissue. Follicles are longer in older birds and the ideal size is from birds of 14-16 month old of age. Table 4 lists the 1996 average value (US$) of different grades of ostrich skin in South Africa (Mellet *et. al.* 1996a).

TABLE 4
Value (US$) of South African ostrich skins by grade and size

Grade	Size (dm^2)		
	130	135	140
A1	230	239	248
A2	184	191	198
A3	86	90	93
A4	3	3 - 11	3

Feathers.
The characters which are most important in determining the relative value of a feather are "quality" bars, plume length and colour deviations. Details of these characters are given in Mellett (1995). The following summarizes the characters (each with five classes) used to grade ostrich feathers:

- Size:
  - length (< 54 cm to > 70 cm)
  - breadth (< 25 cm to > 40 cm)
- Shape:
  - tip (very narrow to broad)
  - butt (narrow taper to square)
  - margin (untidy to smooth)
- Flue Characteristics:
  - strength (weak to very strong)
  - density (sparse to dense)
  - "hand" or softness (hard to silky)
  - lustre or oiliness (dull or dry to fatty)
  - character or description (prickly to parallel barbules)
  - "quality", a combination of hand, lustre, and flue characters
- Damage:
  - wear (no wear to broken tips, plumules)
  - soiling (not dirty i.e. white, to extremely dirty i.e. red brown)
- Other deviations:
  - bars (none or too many bars)
  - flue behaviour (overlapped barbs to no disarrangement)
  - flue style (very open to uniform cohesion)
  - plume behaviour (very bad spiral twist to straight)
  - plume strength
  - shaft thickness (fine to thick)
  - colour deviations
  - general appeal

DISEASES

Difficulties chicks have in hatching predispose them to later problems. Four grades of hatching chicks are recognised:

- Grade 1 Chicks born normally with no assistance - prognosis good
- Grade 2 Chicks pip but cannot get out of shell - prognosis poor.
- Grade 3 Chicks do not pip - prognosis poor
- Grade 4 Abnormal/underweight chicks (< 700 g) - prognosis fair

Ostrich diseases may be categorized according to the main body system affected e.g. respiratory, gastrointestinal, nervous and musculo-skeletal (Table 7). Attention to cleanliness, common hygiene procedures and nutrition will however prevent a large number of these problems. Parasite control and vaccination schedules are given in Tables 5 and 6.

ECONOMICS

Specialization in ostrich farming is a development of the 1990s; before that ostriches were regarded as a component of farm diversification. Table 8 shows the income and costs of a typical farm in the Oudtshoorn area in 1984. In 1996 , the perfect bird with ripe body feathers, an undamaged skin of a minimum $120 cm^2$, approximately 30 kg leg meat, a saleable gizzard, liver and heart, a 1.8 kg neck and a skeleton containing enough meat for by-products, returned US$350. The value of meat was approximately US$70. (Mellett et. al., 1996b).

TABLE 5
Schedule for parasite control for ostriches

	Parasite	Treatment
External	feather lice, quill mite, tick, ostrich fly	Decatix -3
Internal	tapeworm	Lintex or Ex-A Lint (niclosamide), Terenol (resorantel) Cestocur (Prasiquantel)
	wireworm	Panacur (fenbendazole), Levamisole (several trade products available in South Africa)

TABLE 6
Recommended vaccination schedule for ostriches

Disease	Age	Vaccine	Dose (ml)	Route
Necrotic enteritis	6 days	Enterotoxaemia (oil)	0.5	subcutaneous
	7 days	Lamb dysentery	0.5	subcutaneous
	4 weeks and	Enterotoxaemia (alum)	1.0	subcutaneous
	7 weeks optional	Lamb dysentery	1.0	
Newcastle Disease	3 weeks	Inactivated (La Sota) (oil)	0.25	wing tip
	6 weeks	Inactivated (La Sota) (oil)	0.25	wing tip
	3 months	Inactivated (La Sota) (oil)	1.0	wing tip
	6 months	Inactivated (La Sota) (oil)	1.0	wing tip
	every 6 months	Inactivated (La Sota) (oil)	1.0	wing tip

Source: Burger, 1996

TABLE 7
Major diseases, predisposing causes and miscellaneous conditions of ostriches

Respiratory	**Gastrointestinal**	**Nervous/Muscular**	**Miscellaneous**
Viral: - avian influenza	Viral: - enteritis	Viral: - Newcastle Disease	Skin Conditions: - avian pox - fungi - nutritional deficiencies - mites, ticks & lice
Bacteria: - pseudomonas - pasteurella - klebsiella - staphyloccus - bordella - e.coli	Bacterial: - megabacteria	Bacterial: - Clostridium botulinum	Hepatitis (green urine): - a range of viral causes
Fungal: - aspergillus	Fungal: - candida	Toxicity: - pesticides, heavy metals, furazolidone, ionophores, nitrates	Fading Chick Syndrome: - chicks lose up to 10% body week in first week - cause unknown
Environmental: - excessive ammonia - stress - dust - draughts - extreme hot/cold - lack of shelter	Nematodes: - libyostrongulus (wire worm)	Muscle degeneration: - vitamin E and/or selenium deficiency	Infertility: - nutritional deficiencies - embryonic mortality
Aspiration: - inhalation of feed	Foreign bodies: - stick, stones etc.	Paralysis: - hypoglycaemosis (low blood glucose)	

Source: Allwright, 1995

TABLE 8
Income and production costs of a typical mixed Oudtshoorn farm in 1984

Farm Size	
2400 ha	
- 170 ha irrigated	
- 130 ha pasture and lucerne	
Income:	
- Ostriches	R50 000
- Total farm	108 000
Cost of keeping ostriches	5 000
- Cost of feed per bird	220
- Price of day old chick	35
- Price of breeding pair	1 000
Return on slaughter bird	
- Leather	280
- Meat	70
- Feathers	50
Total	400
Rand 3.5 = US$ 1 (1996)	

Source: Ripley, 1987

Chapter 2
Namibia

BACKGROUND

Situated on the south-west coast of Africa Namibia has an area of 825 000 km^2. Angola borders it in the north, Botswana in the west and South Africa to the south and south-east. In the far eastern extremity, the "pan handle" Caprivi Strip is adjacent to Zambia and Zimbabwe. There are said to be no permanent rivers in Namibia but three large rivers define the northern and southern borders: the Cunene on the north-west, the Okavango on the north-east and the Orange River on the southern border.

The country is divided into four topographic regions:

- the coastal (Namib) desert;
- the escarpment and high ridge line of the central plateau running parallel to the coast;
- the eastern (Kalahari) desert; and
- the north-east bush-veldt woodlands.

Apart from the better soils in the far north-east, most are sandy, stony and shallow. With low clay and organic matter content, they also lack water retention capacity and are deficient in several major nutrients including phosphorus.

The climate is arid with evaporation far exceeding rainfall. The rainy season extends from October to May and there is usually an intermediate dry period in December-January. Droughts are common.

In the colonial period, the central plateau area with a higher rainfall and more productive grazing areas was allocated to the commercial sector of approximately 6 000 farms. Farm size averaged 7 000 ha carrying mainly beef cattle, sheep (including karakul sheep) and goats. These are still major livestock producing areas and the livestock sub-sector is the major contributor to agricultural GDP, although the contribution is declining due to low prices and recurring drought. Ostrich farming is favoured as a supplementary or replacement enterprise as the birds thrive in the drier conditions.

Forty percent of the country has been reserved for the indigenous people and is now termed "communal areas". The largest communal areas are found in the north and are home to the biggest ethnic group, the Ovambo. Apart from the far north-east, farming is more difficult in these areas as they are further from government and other support services. Transport adds significantly to costs, and access and use of the land is governed by traditional culture and controlled by the area chief. Farm production remains low with household food security being the most important consideration. Since independence these areas have been beneficiaries of several major aid programmes. Ostrich farming however, remains almost exclusively in the commercial sector although attempts have been made include communal groups.

THE HISTORY OF OSTRICH FARMING IN NAMIBIA

The first ostrich farm in Namibia was started in 1912 with birds imported from South Africa. By 1986, there were two commercial ostrich breeders in South West Africa, which was then part of South Africa. When independence was approaching in 1990, several South African producers established operations in Namibia.

After independence, the Ostrich Breeders Association of Namibia (OBAN), was formed. It published 13 issues of its own newspaper "Birds Eye View", from 1990 to 1995. It now jointly sponsors "SA Ostrich" published in South Africa.

The wild Namibian Blue-neck ostriches used to be considered vermin as they damaged stock fences, and were hunted for sport. Farmers began to harvest eggs and chicks from the wild but this was not efficient and specialized enterprises began to develop. By 1991, there were 3 000 domesticated ostriches in Namibia, mostly South African Black-necks, with some domesticated Namibian Blue-necks. There was one abattoir that met EU standards and four tanneries; the volume of meat and leather however was low, as most production was exported live. Large numbers of fertile eggs and week-old chicks were exported from 1990–1995.

The export of live eggs and chicks was very profitable, and together with the fall in cattle and sheep profits, stimulated an expansion in the number of ostrich farms both in Namibia and in other African countries. In 1993, an FAO report on the production and marketing of ostriches in Namibia recommended that the industry should prepare to change from the short-term, but profitable, live export market to a more sustainable long-term rearing and processing market. This would be achieved though the establishment of quotas on the numbers of fertile eggs and/or live chicks that could be exported from individual farms (FAO, 1993). Export quotas were calculated on the following basis: one and a half times the number of breeding females could be sold per week as eggs, and 50 percent of the total breeding females number could be sold per week as chicks. Total annual exports could not however exceed 10-40 times the breeding female number, the multiple depending on the age of the females.

CURRENT STATUS OF THE OSTRICH INDUSTR[1/]

The industry has expanded rapidly since 1990 and is still growing. By mid 1996 there were an estimated 43 000 ostriches over six months old in Namibia. The majority were in the commercial sector and only 289 ostriches were recorded in the 21 communal areas. There were 131 registered ostrich breeder farms with live egg and chick export quotas, although 18 of these farms were registered in name only as they had sold all their birds. The total number of breeding females registered was 4 716. There were also a number of smaller farms raising chicks for the breeding farmers, but the type of specialized farms found in South Africa which buy and sell birds of different ages had not yet developed.

It is recognised that demand and prices for live exports are falling, despite new opportunities in Asia, and that the industry should now focus on the slaughter market. There

[1] 1996

is therefore encouragement for new farmers to enter the industry and also a demand for local slaughter facilities.

Meat and meat products are prepared for both the export and local markets at the new abattoir at Mariental which can process 250 birds per day and is operated by OSTRACO, a joint venture between Domesticated Ostrich Products (DOP) and MEATCO (the major meat exporter). A new company also planned to build an abattoir at Keetmanshoop in October 1996. Local tanneries can handle all the skins from the abattoirs if required. Only the large plume feathers are retained at slaughter and sold to South African feather firms for grading and marketing.

FACTORS AFFECTING THE DISTRIBUTION OF OSTRICH FARMS

The main distribution of ostriches by administrative areas in 1996 was:

- Mariental-Hardap with about 50 percent of the total birds;
- Gobabis Area with 6 000 birds;
- Omaruru and Windhoek with 2 000 birds; and
- Okahandja (just north of Windhoek) and Keetmanshoop with between 1 000 to 2 000 birds.

The reason for the concentration of birds and farms in the Mariental-Hardap Area is the Hardap Dam, which allows for the growing of irrigated lucerne for feed. The breakdown by farm size (number of breeding females) was:

- 10 farms with over 100 breeding females;
- 20 farms with 50-100 breeding females;
- 50 farms with 10-50 breeding females; and
- 30 farms with less than 10 breeding females

The dry climate in Namibia is highly suitable for raising ostriches but the local vegetation cannot support a large number of birds all the year round. Most farms therefore operate intensive rather than free-range systems, even where there is reasonable rainfall and good natural pasture and vegetation.

Government regulations to control Foot and Mouth Disease (FMD) means that animals cannot be moved or exported from the country north of the "Redline", a veterinary cordon fence, which runs from east to west, north of the Etosha National Park, and encompasses the northern communal areas. There is a buffer "pink" zone south of the "Redline", with a high level of surveillance, and the rest of the country is declared free and can export livestock. These regulations have tended to restrict the establishment of ostrich farms to the south of the buffer zone.

Newcastle Disease (ND) has occurred in Namibia and means that the exportation of ostriches to certain countries is restricted. The veterinary control measures are to:

- keep all poultry one kilometre away from export ostrich farms;
- vaccinate all ostriches against ND;

- separate and slaughter all birds showing clinical signs and/or testing positive for ND; and
- declare a farm free of ND only after two negative blood tests three weeks apart from all ostriches within a 20km radius of the outbreak.

These control measures are accepted by China, Germany and Switzerland, and are being considered by the European Union (EU) as a whole.

To obtain an export permit, farms must meet criteria set by the importing countries. These state that birds must not be caught or killed from the wild, and must come from fenced farms and be fed rations. The Agriculture Department does not have the capacity to inspect all farms and has given OBAN the role of inspecting and approving farms for export permits. Those farms without an export permit can only sell live birds and meat on the local market, and as local prices are lower than export prices, these farms are not thought to be viable in the long term.

The fact that Namibia could export eggs and birds when South Africa had imposed an export ban, has given the Namibian ostrich industry a substantial financial impetus since 1990. Millions of Namibian dollars[2]/ have come into the industry in the last five years, mainly from the USA. The USA market has now declined but other markets, notably in Asia, are opening up.

Traditional land tenure arrangements, which discourage fencing and enclosure, and government quarantine restrictions make ostrich farming more difficult to establish in communal areas. The best means by which communal people can invest in a new enterprise is for them to donate animals, their main asset, which can be sold as equity into a new business project.

FUTURE DEVELOPMENT

Short Term

The sale of live bird sales will continue, but at a slower pace due to a downturn in demand and the opening up of the South African market.

The slaughter industry is young but is expected to increase as more farms start sending birds to slaughter, although slaughter numbers should have peaked by 1997. Many farms were at their breeding capacity in November 1996 and were having difficulty coping with their 1996 crop of chicks. Some farms were contracting out the rearing of young birds up until six months of age, partly due to the lack of capacity and partly because of the disease risk when more than 2 000 birds are kept together.

There are good markets for ostrich meat in Europe, especially in Germany and Switzerland, and it is expected that income from meat exports will increase substantially. Good quality skins and high quality leather goods are also being produced in Namibia. With the increased availability of ostrich skins world-wide, it is expected that the price of ostrich leather will fall, although it is thought that the skin will remain the most valuable product from slaughter birds.

[2] Nambian $3.5=US$1.0

Long Term

The local market for meat and leather goods is not large, so the Namibian industry will have to rely on export markets for expansion in the long term.

The export market for Namibia is subject to the same influences as export markets for other countries, and the demand for ostrich products is a balance between competing factors. There is increasing supply as world-wide production expands but there may also be an increasing demand: the decline in red meat and saturated fat consumption in the developed world, and concern over the outbreak of "Mad Cow Disease" (*Bovine Spongiform Encephalopathy)* in Europe, means that ostrich meat could be advertised as the healthy alternative. A one percent switch from beef to ostrich meat would however require all the present number of farmed ostriches. If ostrich meat were priced at the level of beef it would be reasonable to expect a steady growth in ostrich meat consumption for the foreseeable future.

It is known that the leather returns will not be as high as those in South Africa. The feather follicles in the skin are neither as mature nor as well developed as those produced by the South African industry's three stage plucking. Some growers feel however that the faster growing birds do mature faster, and that follicle maturity is more related to body weight than age. Once the leather market develops, farmers will be able to decide whether it is more profitable to keep birds longer and/or pluck them to obtain the higher value skins.

SUBSPECIES AND STRAINS

Most of the ostriches on Namibian farms are, or are derived from, the South African Black-neck, which were brought in from the Oudtshoorn Area of South Africa prior to independence in 1990. In a few cases, South African Black-necks were illegally imported across the border after separation when South Africa had banned the export of live eggs and birds. Most new ostrich farms now purchase their birds from within the country.

The native Namibian Blue-neck (*Struthio camelus australis)* occurs as different strains across the country:

- **The Kalahari Desert Blue-neck** from the south east has a thin narrow "canoe" shaped body but with a longer neck and legs than the South African Black-neck; and
- **The Namibian Desert (Namib) Blue-neck** from the south west is smaller than the South African Black-neck.

There is no separate count of Blue-necks versus the South African Black-necks, but anecdotal evidence suggests that the proportion of farmed Blue-necks may not be higher than 20 percent. A few farms have only Namibian Blue-necks originally caught from the wild, while some farms have both, and cross-breed. Permits to catch Namibian Blue-necks or to harvest eggs have to be obtained from the Ministry of Conservation and Tourism.

The smaller Namib Blue-neck has not grown as well as the South African Black-neck whereas the Kalahari Blue-neck has outperformed the South African Black-neck in growth trials. The major processor favours the cross between the taller Blue-neck and the South African Black-neck, as the birds reach market weight of 90 kg by 9-11 months.

Namibian Blue-necks raised by hand, even from eggs harvested from the wild, are manageable although not as docile as South African Black-necks. All ostriches can be panicked and strong fencing is always required.

In Namibia feathers are not harvested from live birds, as in South Africa, so the feather follicle is not matured. There is little benefit therefore in leaving slaughter until 14 months of age.

MANAGEMENT SYSTEMS

Studies on the ecology of the native birds undertaken by Sauer and Sauer (1966) in the desert areas of the Kalahari, Namib, Eronga Mountains and Etosha Pan found that adult birds survived well in dry periods and bred large numbers of chicks. Chick survival was good provided that the rains were not too late or too prolonged. No farms however operate a completely free-range system although a few farms allow breeding birds access to extensive natural vegetation but supplemented with a mixed ration. The majority of farms are intensive, providing all the feed and water requirements, and not reliant on native vegetation, even if available.

Because sales of fertile eggs and day-old chicks have been strong, brooding facilities are still being built on many farms. Most farms have their own brooder facilities, although larger farms are either contracting out rearing, or building separate facilities elsewhere. This relieves the strain on staff and facilities and also decreases the risk of large losses should there be a disease outbreak.

A number of farms still rear chicks in sheds on earth floors, but new rearing facilities use raised, expanded mesh for floors, and infra-red heaters. The internal pens are connected to an external concrete pad which is half covered to enable the chicks to adapt to the outside environment. The external pens are connected to lucerne paddocks. Chicks are let out onto the lucerne only when they are eating and drinking well from containers in the pens. This strategy prevents the chicks from overeating lucerne and becoming impacted.

BREEDING AND REPRODUCTION

The size of the breeding pen varies from 4-40 ha and breeding groups vary accordingly from a single pair up to 50 breeders.

In the wild, Namibian ostrich chicks may hatch at any time of the year, but in captivity breeding birds are separated for at least three months, usually June to August when they moult, in order to stimulate mating and egg laying. Mature hens often complete their moult earlier than males and initiate courtship activities by making exaggeratedly aggressive gestures towards other females, and by standing erect and urinating and defecating in front of potential or familiar mates. The nuptial colour of Namibian Blue-neck female changes the metatarsal scutes to black while the scutes and face of the male change to red. On achieving breeding colour, the males initiate mating. Artificial insemination has been studied in Namibia but is not used routinely.

There are two peak laying periods. The first is in September to October, stimulated by the early rains, and the second between February and May after the late summer rains.

Egg production usually declines between November and January. Many farms now record egg data and have criteria for maximum egg numbers for certain age classes. For example, first year lay (2-3 year old) 40 eggs; second year 60 eggs and third year > 80 eggs.

Once the hens have laid their maximum number of eggs the males are removed and the hens cease lay. Farms that do not separate males to control egg production have recorded over 130 eggs from certain hens in a season.

Some farms separate birds during December and January and others also vary the feed intake during this period to manipulate the body weight of the birds as required. Males will often put on weight during the breeding season because they eat the same high quality breeder rations fed to the females. There are no strategies to prevent this, other than mid or end of season separation and a restricted diet.

INCUBATION AND HATCHING

The same handler collects eggs once or twice a day and regular routines are maintained. No gloves or disinfectant are used during collection. Eggs are placed in individual plastic moulds in crates holding nine eggs and carried by two people. Dirty eggs are washed with a mild disinfectant solution. Eggs may be stored on their side or on their end in a cool egg room. They are then candled and set with the aircell upwards and turned once or twice a day through 90° (45° each side of vertical).

Prohatch® and Natureform® automatic incubators and hatchers are used, some with 4 000 egg capacity. Candling is performed when eggs are placed in the incubator to determine correct orientation, and again at seven to ten days to determine fertility.

Eggs are transferred to the hatcher at 39 days of incubation where they are held upright, and chicks hatch into individual compartments. The eggs are candled daily to monitor pipping and position of the beak and claw of the hatching chick Assistance is given if the chick has penetrated the air sac but become lethargic, or has broken the shell but fails to break out after 12 hours.

BROODING

Chicks may be left in the hatcher for observation and to dry off for two days before being placed in a heated nursery, usually in, or close to the hatchery. Feed and water need not be given for four days.

When strong and active enough, chicks are placed in a brooder pen with infra-red heaters and a non-slip floor of mats which are cleaned daily. Numerous coloured chick feeders and drinkers are placed around the pen. Initially feed is scattered on the floor but chicks are encouraged to eat from the feeders by tapping and placing small amounts of green feed and/or egg shells on the feeders. Chicks are kept in the brooder pen for one to two weeks but may be allowed out into yards, if dry, after ten days. Chicks at this stage are attended to 24 hours a day by employees - the "Chick Mothers".

GROWING TO SLAUGHTER

From 2-12 weeks chicks may be moved through three sets of facilities, each of increasing size but still providing shelter and a run. From three months onwards the birds are left in a paddock without a shelter. Half tyres are used for feeders and water troughs, and the birds are fed a mixed ration each day. Farms that do not have grazing may include lucerne meal in the ration.

Birds are grown to the accepted slaughter weight of 90 kg, which may take 9 to 15 months, although the average is 11 months. Slaughter age is determined by body weight and not by feather or skin characteristics.

NUTRITION AND FEEDING

Almost all farms buy mixed feed and a typical feeding regime is:

Age	% Crude Protein
0 - 4 weeks	21
4 - 12 weeks	18
12 weeks - slaughter	15
breeders	14

Rations contain a large amount of roughage, usually lucerne, and any material actually grazed or browsed is not considered part of the nutrient intake. Young chicks are given vitamin and mineral supplementation, chopped green feed (lucerne or spinach) and pro-biotic supplements in the water.

FACILITIES AND HANDLING

Perimeter security fences should be at least 2.2 m high and may be electrified. Seven strands of plain wire are used, or the lower section may be covered with wire mesh. Internal fencing varies from 1.2 to 2.0 m, depending on the size of the birds, and a gap of least 0.5 m from the ground is left to prevent birds catching their feet and to provide an escape route for staff.

Shade is only provided in paddocks for chicks up to three months of age. Handling yards use forcing gates to move birds progressively into smaller pens and finally into the crush and chutes. Birds get used to a routine of the handling yards and can be regularly inspected and weighed. Mobile ramps are available for loading birds onto trucks.

Transport consists of trucks divided into compartments which hold 3-12 birds plus an attendant. Partitions are made from smooth metal sheets and wet sand is placed on the floor. The top either has a canvas cover or is left open. There is differing opinion as to whether the top should be covered a canvas cover: leaving the top open prevents birds sitting down and being trampled, while the darkness provided by a cover helps keep the birds calm.

Egg collectors work in pairs, one to distract the male bird, and one to pick up the eggs. A single straight stick held beside a collector increases the birds' perception of the collector's height, remembering that a male ostrich will not attack a taller animal. A forked or barred stick is used to push away the neck of the bird.

SLAUGHTER AND PROCESSING

The largest abattoir, Ostracho, in Mariental, has a capacity of 250 ostriches a day and is also equipped to slaughter sheep and game The abattoir opened in May 1996 and by September was slaughtering 50 birds per day.

Procedures are similar to those used in South Africa. Birds are brought in the day before, held in yards overnight, and slaughtered the next day. Farmers pay for the transportation to the abattoir. No feed or water is provided unless the birds need to be kept longer. Birds are caught singly, hooded and moved up a ramp where they are stunned through the hood for 18 seconds at 90 volts and 1.5 amps. Rubber covered clamps are provided to hold the legs down to prevent kicking. The birds are lifted on a shackle over a bleeding trough, where the jugular vein and carotid artery are cut, and are bled out for ten minutes.

There are five pluckers, each with a particular section of the bird to pluck. The first two remove the saleable feathers (wings and tail plumes), which are sold to a grader in South Africa.

The skin is removed without worrying about the adherent fat. The fat layer is cut down to < ½ cm prior to salting. A thick layer of dry salt (6 kg/skin) is placed between each skin, and they are then placed on a stack and left to drain for a day. No brine, antibacterial agent or refrigeration is used for the first day. Skins are then rolled with the salt inside and refrigerated, and sent to the tanner once a week.

After skinning, the bird is hung by the wings, the breast bone is cut out and the thoracic organs removed. The liver and heart are placed on a tray and the viscera removed for inspection. Facilities are provided for the veterinary inspector who undertakes the ante and post-mortem inspections. The inspected carcass is stamped with dye. An in-house inspection ensures that any unattractive meat is removed.

The carcass is boned out into individual muscles which are classified into fillet and steak. The fillets are the fan fillet (N$25/kg), oyster fillet and flat fillet (N$18/kg); the rest of the muscles are packed as undifferentiated steak (N$15/kg). All muscles are trimmed of sinew, any membranes removed and then vacuum packed. The trim is graded. Grade A trim goes for processing into polonie and sausage, while Grade B is sold fresh for N$2-3/kg.

The abattoir pays the producer by the grade of the skin. An initial payment of N$1000 per bird is made the week after delivery to the abattoir. The second payment occurs 60 days later and depends on the grade awarded after the skin has been tanned.

DISEASES AND QUARANTINE

Diseases

Farmed ostriches in Namibia do not appear to suffer from many diseases but those that do occur are similar to those found in South Africa (see Table 5, Part II, Chapter 1). Veterinary opinion is that 20 percent of ostrich problems are disease related and 80 percent management related.

The most common problems encountered are:

- deseases affecting fertility and hatchability;
- spraddle and twisted leg;
- bacterial respiratory infections;
- *Clostridium perfringens* infection;
- roundworm worm and tapeworm infections; and
- external parasites.

Particular problems associated with young chicks (1-3 weeks old) are:

- inappetance leading to starvation;
- demenger or eating rubbish;
- impaction usually caused by eating sand but also by stones, stalks, or grass fibres;
- bent legs and twisted toes;
- mixed bacterial infections;
- hypothermia, especially from getting feathers wet; and
- Trauma, commonly being attacked by a larger bird.

The usual range of control measures against external and internal parasites, Newcastle Disease and *Cl. perfringens* are given (see Table 6 and 7, Part II, Chapter 1).

Quarantine

Most farms use cattle ear tags attached to a flap of skin on the neck to identify their birds. Such tags however are easily pulled out and lost, and are not accepted as a permanent identification. For a farm to be registered for export, all birds must be permanently identified. Microchips are used but they have the disadvantage of moving away from the site of application and need the detector close to the bird to read; they are thus slow to process. Alternatives being considered are tattoos and branding.

Other export conditions, such as Newcastle Disease control measures, have been mentioned previously. Meat from the Foot-and-Mouth Disease northern buffer zone can only be exported after it has been stored in frozen vacuum packs for three weeks to ensure that no cases of FMD are detected during that period.

To prevent the entry of *Bovine Spongiform Encephalopathy* (BSE) into the country, Namibia has banned the importation of meat from the United Kingdom and Northern Ireland. It also imports fish meal only from registered rendering plants that cook the meal at 300 kpa for 30 minutes.

ECONOMICS

The following are standard production ranges and costs and returns for ostrich farming in Namibia in 1996 (N$3.5=US $1):

Production ranges:

Egg production:	15-20 eggs (2-3 year old hens)
	40-80 eggs (4+ year old hens)
Hatching %	50-90% of eggs set
Mortality:	10-40% from day-old to slaughter
Slaughter weight:	90 kg at 9-11 months
	120 kg at 12-14 months

Capital Investment:

Breeding Birds:	N$4 000-10 000 per adult
Breeding camp facilities:	N$3 500/ha
Chick camp facilities including brooder house ($75\ m^2$) and brooders:	N$3 200

Recurrent costs:

Feed:	N$ 900/adult breeder
	N$ 800/chick to slaughter
Medicines, vaccines,	N$18/adult breeder
supplements:	N$3 /chick to slaughter
Labour:	N$36/chick to slaughter
Hatching costs:	N$20/egg set
Marketing:	3-3.5% of total costs

Returns:

Slaughtered bird:	N$1 000
Skins:	
- A grade skin	N$500
- B grade skin	N$250
- C grade skin	N$ 0
- D grade skin	deduction
Live birds:	
- 3 year old	N$4 000-10 000
- 2 year old	up to N$3 000
- day old chick	N$150

Chapter 3
Zimbabwe

BACKGROUND

Zimbabwe is a landlocked country of approximately 400 000 km^2, roughly circular in shape and lying in the same latitude as Madagascar. It is surrounded on its eastern and north-eastern border by Mozambique, Zambia on the north-west, Botswana on the south-west and on the south by the Republic of South Africa. In the north-west the rivers run into Lake Kariba which feeds the Zambezi River, both of which form the border with Zambia. In the south-east many of the rivers run into the Limpopo River on the southern border with South Africa.

The country consists of three plateaux, one on top of the other, at 900 and 1 200 m above sea level. The high central plateau, the Highveld, runs diagonally across the country from the south-west to the north-east, where the border range reaches 2 500 m. The capital, Harare, sits approximately in the centre of the north-eastern half of the Highveld. To the south-east and north-west of the Highveld, the land slopes to a second narrower plateau, the Middleveld, and then to the Lowveld.

The central plateau has a cool climate with good rainfall but the lowlands are hotter and drier. Rain falls in a five month wet season from November to March, although run-off is rapid and evaporation high.

The population of 11 million people is growing at the rate of three percent per year and the *per capita* Gross National Product (GNP) was US$650. The population of Harare is one million, and other than that, there are few large towns, seventy percent of the people living in the rural areas. Unemployment levels are high outside the main cities and the government is keen to support rural industries and counteract the growing urban migration. Many smallholder farms still operate at close to subsistence level with little surplus production to provide an income. Most people in the cities still maintain close links with their homeland and many may keep a smallholding. Ostrich farming is seen to be more profitable than keeping cattle, and an important source of rural employment.

The country is divided into eight Provinces, each with an Administrative Centre which provides the base for agricultural and educational services. In the north, the three Provinces encompassing Mashonaland contain 75 percent of the population and radiate out from Harare. The second largest city, Bulawayo in the south-west, lies in the centre of Matabeleland and is the homeland of the Ndebele people, who represent 18 percent of the population.

There are four classifications of land tenure:

- large scale titled deed land;
- small scale titled deed land;
- communal land (previously Tribal Trust lands); and
- government reserves such as National Parks.

THE HISTORY OF OSTRICH FARMING IN ZIMBABWE

Ostriches are native to Zimbabwe and the country forms the north-eastern extremity of the natural distribution of the native South African ostrich sub-species *Struthio camelus australis*. The ostrich was considered a pest by the early settlers although there were sporadic attempts to incubate ostrich eggs and raise chicks from the wild.

It was not until 1976 that an officer of the Department of National Parks and Wildlife Management (NPWM) started to raise ostriches from eggs taken from the wild. This farm became a commercial enterprise in 1985. At the same time there was growing interest in ostrich farming following information about the demand and high prices paid for ostriches, especially in the USA.

Ostriches, as with all native/game animals in Zimbabwe, come under the control of the NPWM Department, and permits have to be obtained to take them from the wild. Adults, chicks and fertile eggs have all been taken to start farm ventures, but an equivalent number of birds must be released back into the wild. Wild ostriches are not protected and their sustainability needs to be continually reassessed, as the number has declined. Many of the surviving wild ostriches are now found on cattle ranches. Even though most of the ostriches are on private farms, ostrich farming is still controlled by the NPWM Department; however the farmers have requested that control be transferred to the Department of Agricultural Technology and Extension Service (Agritex).

As the popularity of ostrich farming spread, farmers began requesting loans from the financial institutions. However, only farmers with large areas of freehold title were able to offer sufficient security, and it was in these that ostrich farming became established. The present size of these farms is from 10 to 300 breeders.

The objective of the initial farming ventures was to supply live birds and fertile eggs, primarily for the export market. Live birds and eggs have been exported to 18 countries but the most profitable trade with the United States of America has now ceased.

Producers formed "The Ostrich Producers Association of Zimbabwe" (TOPAZ) in 1986 and, two years later, a trading company called "Copro". Of the 250 TOPAZ members, 115 are shareholders of Copro, although Copro now operates independently of TOPAZ. In 1995 Copro built a modern specialized ostrich abattoir at Norton, close to Harare, which has a capacity of 15 000 ostriches per year. It gained export approval in June 1996 and is now exporting to European countries as well as Japan.

The large ostrich producers in Matabeleland decided that they needed their own abattoir and in 1991 they formed the Bulawayo Ostrich Processors (BOP). This is a private limited company of 50 producer shareholders. In 1994 BOP approached the largest meat processing company in Zimbabwe, the Cold Storage Commission (CSC), and funded the extension of one of their small-animal abattoirs in Bulawayo to process ostriches. The BOP abattoir is "state of the art" export approved, and its ostrich meat is sold to Switzerland, Belgium and Japan in chilled, sealed packs. This factory has a capacity of 300 birds per day but by October 1996 only 75 were being processed on one day each week. Throughput is expected to peak at about 250 birds per week in November when the previous year's chicks reach 90 kg.

In 1993 the United Nations Development Programme (UNDP) provided ZIM$3.5 million (Z$8.35 = US$1), to assist small-scale ostrich farmers who could not raise sufficient funds from bank loans. The funds were channelled through the "Africa 2000" group. Assistance was provided in the form of fencing material, birds and feed, as well as a farmer training programme. The size of the farm units is five birds (two male and three female) per hectare although some farmers may own one or more units. In the three years of operation of one of the assisted projects (CHESA Project), seven farmers have been trained and are now ostrich farming.

A number of small-scale farms have started ostrich production on their own. In 1993, the Small Holder Ostrich Producers Association (SHOPA) was formed but ceased operations in 1994. A year later the small-scale producers formed the Zimbabwe Ostrich Producers Association (ZOPA). This association now has about 400 members who between them farm about 2 500 birds.

Agritex provides farmer training at their research and training farm in Domboshawa, 35 km north-east of Harare. This farm has a hatchery equipped with a locally built Barret incubator and hatcher, a simple brooder, a series of chick grower pens and a set of eight one hectare yards in a circle around a central work yard. Trainee accommodation is also provided on site. The Ministry of Agriculture has funded all training materials. Trainees are usually placed on a commercial ostrich farm for one to two months in order to gain practical experience .

In July 1996, the French Government provided $Z3.5 million to establish 11 central hatching facilities in selected Districts, including one at the Domboshawa Government Farm. The aim of this project was to extend the pilot "Africa 2000" programme to the provinces and provide incubators close to small scale ostrich farms. It is expected that 144 smallholder farmers and 60 extension staff will be trained in ostrich farming by the end of the programme (Anon. 1995).

It is proposed to establish provincial training centres for farmers from the communal areas so that they can participate in ostrich farming. One of the problems associated with site selection is the limited and unreliable distribution of electricity.

FACTORS AFFECTING THE DISTRIBUTION OF OSTRICH FARMS

Ostrich farming can be found throughout the country; however the size and geographic distribution of the enterprises are largely determined by the three types of commercial land:

- large-scale commercial farms on the better quality (generally red and black loam) agricultural lands of the Highveld;
- small-scale titled holdings generally found in pockets of poorer quality sandy loams in the Highveld; and
- communal areas in the extensive poorer quality, sandy soils of the former tribal trust lands of the middle and low veld.

Profitability of agriculture is variable and more so in the communal areas. Intensive ostrich farming is seen as having the potential to be profitable in all three areas to increase rural incomes.

Ostriches have not been part of the local culture in Zimbabwe and little use is made of their products, which have to compete locally with beef. Hotels and restaurants are the main consumers, although there is a growing local demand for the low priced off-cuts.

CURRENT STATUS OF THE OSTRICH INDUSTRY [1/]

The ostrich industry in Zimbabwe is becoming well established as more farms have birds being turned off for slaughter. Initially all farms kept their stock for breeding with a few cull birds being slaughtered, and it took three to four years before the first batch of slaughter birds reached the marketable age of 12-14 months.

There are now 150 commercial farms and the estimated population of ostriches kept in captivity is 32 500, of which about 3 000 are adult females. The number of offspring is low but increasing annually. Recent surveys (Revol 1996 and Haxen 1996 pers. com.) indicated that females laid an average of 27 eggs, from which ten chicks hatched, six chicks survived to three months of age, and two were marketed at 10-14 months of age.

There are two export abattoirs and three tanneries in operation. Processing capacity is three to four times the 1996 production level. Ninety percent of their products are all being sold overseas. Veterinary support for the industry is excellent. The Department of Veterinary Services (DVS) outside Harare provides a post-mortem and disease diagnosis service; it also undertakes research on husbandry and inspects farms and premises for export licences.

FUTURE DEVELOPMENTS

Although there are no government restrictions on ostrich farming, new large-scale farms will probably be in a position finance themselves, especially as the bank interest rate for loans are 30-40 percent and approval can take up to one year.

The major expansion in the future is expected to be in the smallholder sector, where costs are lower and ostriches can integrate well into the traditional pattern of mixed farming. Farms produce grains and legumes which can be used as feed. Ostriches can also be farmed with other animals, with the exception of domestic poultry for the export market, and they integrate well with tree-crops, such as citrus. Manure from the birds is a good fertilizer and the birds keep the trees free of insect pests and do not eat the leaves. Ostriches offer diversification away from cattle keeping and they have several advantages in that less water is required, growth rate is faster and reproductive rate is higher.

Over one thousand smallholders have expressed interest in commencing ostrich farming with assistance provided by the two overseas aid schemes: Africa 2000 and the French Government. Additional assistance in the form of low interest loans to commence ostrich farming is being sought.

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[1] 1996

SUBSPECIES AND STRAINS

The native ostrich of Zimbabwe (*S.c.australis)* is a large blue-necked ostrich and characterized thus:

- The skin of the neck, body and legs is grey-blue, paler than the skin colour of the northern (Somali) Blue-neck, *S.c. molybdophanes*.
- There is no bald patch on the top of the head but there may be a narrow ring of white feathers at the base of the neck.
- The tail feathers are dirty brown.
- The upper and lower bill edges are bright pink to red in males in the breeding season.
- The feathers have curled barbs.
- Nine month old birds weigh 100 kg and breeding birds weigh 140-160 kg.
- Birds have a more rapid growth rate than the South African Black-neck and yield more when slaughtered at 10-14 months of age.
- Birds keep to their own territories and do not fight, resulting in less skin damage and scarring from claws.

MANAGEMENT SYSTEMS

Ostrich farming practices in Zimbabwe are well described by Foggin (1995) and in the booklet "The Topaz Introduction to Practical Ostrich Farming" by Hallam (1992). Three main management systems are described, namely:

- *intensive*: pairs or trios in pens of 0.25-0.5 hectare and completely hand fed;
- *semi-intensive*: the most common practice with groups of 5, 15 or 30 breeders (with an appropriate ratio of males to females), kept at a stocking rate of between 1-10 birds per hectare allowing some access to local vegetation;
- *extensive*: a large area of bush, with birds relying on natural vegetation and possibly some supplementary feeding.

Only a summary of the main management practices will be given here:

- Nests are generally made close to fence lines and eggs are collected daily.
- Natural incubation may be practised, but most eggs are incubated artificially.
- Centralized hatching at District level is being planned by Agritex to meet the needs of small-scale producers, especially those without electricity.
- Most chicks are raised using artificial brooders for four days up to four weeks.
- Four week old chicks are bulked into groups of 50-70 and placed in 3 x 3m pens in a shed, with access to an outside run.
- Chicks may be moved to pens with higher walls until three months of age, when they are moved to grassed yards.
- At four to six months of age young grower ostriches are moved to outdoor yards without shelter. Fifty growers may be kept in a 2-3ha paddock. Some farms have a series of pens and yards and move the birds each month until they reach slaughter age.

BREEDING AND REPRODUCTION

There are two breeding seasons, the first from July to September at the end of the dry season, and the second from November to January in the middle of the wet season. Conditions and results are better in the first period, as eggs are cleaner and drier with fewer rotten eggs and better fertility, hatchability and survival.

Ostriches are flock animals and move around together. Some farmers prefer to separate the sexes in the non-breeding seasons, so that the birds are out of sight and hearing of each other. If the sexes are left together, mating and egg laying may commence as early as May.

If separated, birds are placed together again in July. Males appear to mark out their territories in the pen, and the size of the territory varies depending on the total number of breeding males in the pen. Mating males do not appear to interfere with each other and, as kantling time is short, most mating rituals appear to end in copulation. Males are very active and may mate with females every half hour or so throughout the breeding season. Low sperm counts and low fertility may result from excessive mating activity. Semen examinations can be requested through the Department of Veterinary Services to check sperm counts.

Fertility levels of females may range from 50 to 85 percent, and higher fertility is thought to be a response to better nutrition. A breeder pellet containing a calcium supplement is fed, but no additional supplements such as shell or insoluble grit are given. There is differing opinion as to whether or not to reduce nutrient levels for one month between the two flush periods, to try to increase fertility levels.

INCUBATION AND HATCHING

Eggs are collected daily by hand and stored on their end or side in the incubation room for up to one week. Many eggs are washed or wiped clean with a damp cloth, but dry brushing is increasingly being used. If eggs are transported to another incubator, they must be well padded and not placed on the floor of the vehicle.

Large home made walk-in incubators and hatchers are still widely used and only a few farms have modern, automatic incubators. The locally manufactured "Barret" incubator is popular. It is a plywood box measuring approximately 1 x 1 m with four (5 cm) ventilation holes and two internal fans to circulate air. A thermostatically controlled heating coil is supplied and air flow, temperature and humidity settings can be varied: commonly 36.2° C, and 18 to 30 percent RH have given good results.

Eggs are placed either on their sides or on end in two frames that oscillate 2-12 times a day to turn the eggs. Eggs need not be turned for the first three days. Fumigation, humidity control and egg weight loss monitoring are undertaken by some, but not all producers. Eggs are candled at ten days to check for fertility, and again on day 39 before being transferred to the hatcher.

Shells are broken to assist chicks which are not hatching on time and navels sprayed with terramycin. Unhatched eggs are broken open to determine the age and cause of death.

BROODING

Floors of the brooding pen are made of rough cement to prevent slipping and in addition, hessian bags are placed in the brooding area to provide extra warmth. The bags are brushed clean daily and washed in disinfectant every second day. The floors are not hosed but are swept clean. One farm covers the floor with a 5 cm deep litter of chopped lucerne leaf which is changed every two days. Another common practice is to place several older chicks with young chicks to teach them to feed and drink. Fresh dung may also be fed to chicks to help establish the gut flora.

It has been found that if the nutritional requirements or green supplements are not adequate, chicks will tend to peck at anything and there is a danger of their becoming impacted. It has also been found that if chicks become wet, they quickly die, so they are not allowed out of the brooding pen in wet weather. Since there are no aerial predators, outside covers are not necessary but shade cloth may be used over a section of the run.

GROWING TO SLAUGHTER

From 3 to 15 months each batch of birds is kept separately. It is not recommended to mix ages after the first few weeks, as the smaller birds may be bullied and not given access to the feed trough.

Birds of either sex will be slaughtered from 10 to 15 months of age at a liveweight of around 100 kg. Birds destined for breeding may be separated by sex at this age and will not be placed together again until two years of age.

NUTRITION AND FEEDING

Two large feed mills and several smaller mills produce a range of ostrich feeds in Zimbabwe. Proprietry pelleted feed is used and the ration formulated for specific purposes: starter, grower, adult maintenance and breeder. Diet specifications are based on South African recommendations, typically with an 18 percent crude protein for starter rations, 15 percent crude protein (CP) for grower rations, and 14 percent crude protein for finisher and breeder rations, with commensurate metabolizable energy (ME) levels decreasing from 11 to 9 MJ/kg. Some farmers control water and food intake by making them only available only during certain hours of the day.

Feed is put out daily a rate of 2 kg for yearlings and adult maintenance, and 2.5 kg for breeders. Green feed, either as chopped fresh forage or lucerne meal is added at the rate of approximately 2 kg DM(dry matter)/day. In the paddocks birds may obtain their own green pick.

Flat trays are used for chick feeders, and small bottle drinkers are placed in the pens and runs for young chicks, while automatic drinkers are used for older chicks. For growers and adults, feed troughs are usually made from inverted tyres to which a rubber floor is welded and small automatic drinkers are placed along on the fence-line.

FACILITIES AND HANDLING

With extensive systems few facilities are provided, and on occasions ostriches are even placed in cattle paddocks without any change to the fencing. Free-range birds are difficult to catch and various strategies are employed to get the birds used to closer confinement. Handling yards are built on most farms and feed may be placed in the yards to get birds used to moving through them.. Birds may also be enclosed in handling yards at night and herded back to their paddocks during the day.

The handling yards used for semi-intensive and intensive systems keeping growers and breeders are similar. Fence height is between 1.8-2 m consisting of 6-8 strands of 10-12 gauge wire starting 45cm above the ground. Posts are placed 5 m apart with droppers at 1-2 m intervals. If jackals are a threat, 600 mm pig mesh is used. Often the top wire is replaced by a pole rail, or the entire fence may made of post and rail. Loading ramps are usually built into one corner of the yard and birds are pushed up the ramps into trucks for transportation to other farms or for slaughter.

Birds are handled to check and treat for injuries and external parasites. Feathers may be plucked in the yards. Young chicks are held by the base of the neck and lifted by a hand under the abdomen. Older birds are caught by the neck with a crook and the head held from behind and lowered, while the bird is pushed from behind. Protection from aggressive birds is by a thorn bush 2 m long or a set of bicycle handle bars on a long pole to push the neck or chest away.

Birds have been successfully transported over 500 km in cattle trucks with rubber mats on the floors and padded internal divisions. Individual compartments of 18 m^2 can safely contain 12 birds and a handler.

SLAUGHTER AND PROCESSING

Initially birds were slaughtered on the farm, and still are in some cases. However, the meat cannot be sold and can only be consumed on the farm, although the sale of skins is permitted.

Saleable meat must come from birds slaughtered at an approved abattoir. Both the COPRO and the BOP/CSC abattoirs have modern facilities, and use standard ostrich slaughter dressing and packaging procedures.

Birds are stunned electrically using 90 volts at 0.5 to 2 amps. The neck blood vessels are severed, the bird is raised off the ground, and the heart vessels stabbed to decrease the bleeding time. The birds are plucked and skinned and the head and lower legs removed. Viscera are removed from birds suspended either by the hocks or wings. Both the viscera and the carcass are inspected before chilling overnight.

The meat is boned out the next day and vacuum-packed or frozen for both the export and local market. There is little demand for the liver, offal or bones.

Skins are washed and soaked in cold brine for 1-24 hours before being salted and stacked for three days. They are then folded into sacks and stored in a refrigerator at 4°C for up to six weeks. Good quality skins are tanned to the crust stage and exported. Lower quality skins are fully tanned in Zimbabwe and made into clothing and accessories locally.

DISEASES AND VETERINARY SERVICES

Mortality levels vary greatly between farms and between seasons, and may be as low as zero or as high as 90 percent. Mortality for the first two weeks averages at 5 percent per week, and from 2 to 12 weeks 2.5 percent per week.

Parasites

Ticks and feather lice are common and are controlled by dexamethrin or other similar pyrethroid sprays. Helminth infestation is low as most farm stock has been obtained from hatching eggs taken from the wild. Any infestations with *Libyostrongylus douglassi* or *Houttuynia struthionis* are controlled by repeated dosing with a variety of anthelmintics at short intervals.

Intestinal diseases

Proventricular and gizzard stasis and impaction is commonly found on most farms. *Candida* and *Megabacteria* have also been isolated from the upper digestive system. Yolk retention and yolk sac infection are common, as are enteric and septicaemic bacterial infections. A commercial (sheep) vaccine has been used to prevent cases of acute enteritis caused by *Clostridium perfringens*. Paramyxo and corona virus particles have been isolated from cases of enteritis and typhlocolitis.

Nervous diseases

Lentogenic Newcastle Disease has been isolated, but its significance is unknown as it may be the vaccine strain. Velogenic Newcastle Disease virus is present in the poultry flocks in Zimbabwe, and grower and finisher ostriches on eight farms have been affected by nervous signs such as neck paralysis. Newcastle Disease vaccination of ostriches is not permitted unless a poultry Newcastle Disease outbreak occurs within 5 km of the farm. Ostrich farmers have assisted in vaccinating all poultry within 15 km radius of their farms to try to prevent the transmission of velogenic Newcastle Disease virus.

Respiratory diseases

Aspergillus and *Pseudomonas* cause similar lung and air sac lesions to those in chickens. These diseases are controlled by good hatchery and brooder hygiene.

Nutritional deficiencies

No nutritional deficiency has been confirmed in Zimbabwe but manganese and selenium like deficiency problems have been recorded.

Physical problems

Leg rotation is a major cause of chick mortality with an incidence of 50 percent on some farms. Contributing factors are thought to be genetic susceptibility, poor incubator control, overfeeding, slippery floors and inadequate exercise. Trauma to the neck and limbs also occurs frequently.

Veterinary Services

In order to meet strict quarantine restrictions on imports to Europe, the Veterinary Services Department has proposed a set of protocols for the control of notifiable poultry diseases such as Newcastle Disease, Viral Enteritis, Fowl Pox, *Megabacterial* gastritis, *Pseudomonas* septicaemia, Salmonellosis, Coccidiosis, Cryptosporidiosis and Helminthiasis. The Department has also proposed a set of requirements for farm certification and for birds, eggs and meat intended for export.

ECONOMICS

Approximate costs of equipment and consumables for small-scale ostrich farms in Zimbabwe in 1996 were as follows. For an estimate of costs of establishment and maintenance of large-scale ostrich farms in Zimbabwe see Pistorius, 1995.

Establishment costs (US$):

- cost of adult breeding birds	$500
- fencing (per hectare)	4 300
- water trough	15
- standby generator	1 150
- Barret incubator and hatcher	1 550
- chick pen (28 x 3m)	620

Variable costs (US$):

Feed:	
- breeder pellets	$250 /tonne
- maintenance pellets	170 /tonne
- chick starter	350 /tonne
- grower meal	240 /tonne
Labour:	40 /mth
Veterinary supplies:	1 /bird
Transport:	18 /bird
Fuel:	12 /bird
Maintenance:	10 /bird
Water charges:	2 /bird
Electricity charges:	12 /bird

Returns (US$):

- day-old-chicks	$6
- month-old-chicks	18
- each additional month	12
- slaughter birds	see below

COPRO in 1995 purchased birds at the farm gate for US$1/kg cold-dressed-weight, at an average carcass weight 50 kg. Transport and slaughter costs were paid by COPRO. In Zimbabwe in 1996, ostrich meat retailed at about US$2.60/kg, similar to beef, but exported meat returned US$7.0-9.50/kg F.O.B. Transport costs are high. Crust-tanned skins returned between US$350-450. Exported hatching eggs had returned US$100, and a two year old live bird sold for export would fetch US$2 750.

Chapter 4
Kenya

BACKGROUND

Kenya has a land area of over 570 000 km^2 with a good sea port and beach resorts on its Indian Ocean coastline. It is bordered by five countries: Somalia to the north-east, Ethiopia and Sudan to the north, Uganda to the west and Tanzania to the south.

The Equator runs through the centre of the country and through the highest point, Mt. Kenya, the geographical centre of the country. From the glacial slopes of Mt. Kenya, the land slopes gradually in all directions to flatten out to the peripheral plains and hot humid coastal strip. The well watered fertile volcanic soils around Mt. Kenya support most of the agricultural production and about 80 percent of the population. The drier grasslands (Nyika) support large quantities of wild (game) animals. The north-east quarter of the country is desert. Both the grassland and the desert are home to the nomadic herdsmen, including the Masai. The Rift Valley runs along the western and south-western border, and although it contains a string of lakes, it is mainly dry and unproductive.

There are six natural geographic regions:

- the hot humid coastal belt;
- the Nyika Plateau Savannah Grasslands;
- the Foreland Plateau;
- the fertile Kenya Highlands;
- the generally poor Nyanza Low Plateau; and
- the arid Northern Plain Lands.

There are two wet seasons. The long rains occur from March to May and the short rains from October to December. The rain, however, falls mainly on the coastal strip and on Mt. Kenya. The rest of the country has a low, erratic rainfall, and is rarely free of the risk of drought. The lakes, rivers and underground water mean that water is available, but at a cost, since water supplies are metered and charged.

Kenya's population is estimated at 25 million, most of who live in, or within 200 km of the capital Nairobi. The population is growing at 3.5 percent per annum, faster than the economy, consequently the government is encouraging a large range of development schemes, from mining to tourism. Agriculture, horticulture and ranching nevertheless remain the source of livelihood for the majority of the people.

The British started to settle in Kenya in the 1880s, and took and farmed most of the fertile land. Many Kenyans of British descent still live and farm in Kenya, but after independence in 1963, the Government bought out many of the larger farms and initiated major resettlement schemes in the highlands. Most of the ostrich farms in Kenya are found within a 200 km radius from Nairobi.

There are over 40 ethnic groups in Kenya, each with its own language, but English and Swahili are the official languages. Most ethnic groups retain a link with livestock in their culture and many continue a tradition of nomadic lifestyle.

The largest sector of the economy is tourism, which is based on the extensive network of national and marine parks, mostly under the control of the Kenya Wildlife Service (KWS). Hunting of wildlife has been banned since 1993, but the concept of farming and harvesting wildlife is gradually gaining acceptance by the government and the KWS. The wildlife now harvested from private properties includes wildebeest, hartebeest, zebra, gazelle and ostrich.

THE HISTORY OF OSTRICH FARMING IN KENYA

Ostrich farming in Kenya is a relatively recent venture. The largest farm, Masai Ostrich Farm (MOF), was only established in 1991, and the industry is still in its infancy with about 2 500 breeding birds. By 1996 there were about 30 farms, varying in size from 4 to 1 200 birds. The majority of these farms lie in the area between the agricultural cultivation and the Masai homelands in the south, and there are no ostrich farms in the northern third of the country.

The main criteria for a suitable location for ostrich farming are availability of reasonably priced land and proximity to Nairobi. Water is also a major consideration: Nairobi is constantly supplied by permanent melting snow on Mt. Kilimanjaro, which can be supplied to farms at a price. Water is also available from bores of various capacities.

The Kenyan Ostrich Producers Association (KOPA) was formed in 1993 and the majority of ostrich producers are members. KOPA has successfully lobbied the Government for assistance in gaining approval by the European Union (EU) for live birds and product exports which fulfil EU requirements, such as testing for Avian Influenza antibodies. The industry remains under the control of the Kenyan Wildlife Service (KWS) and not the Department of Agriculture.

CURRENT STATUS OF THE OSTRICH INDUSTRY[1/]

The Kenyan ostrich industry is marketing good quality products as well as live birds, which are gaining acceptance for their size and fast growth. A number of producers however have gone out of business due to the lack of sales. One quarter (ten) of the farms operating in 1994 are no longer in business. Most of the other farms are not in active production and appear to be waiting to see the degree of success of the leaders.

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[1] 1996

European Union regulations exclude Kenya from their third country list, which effectively bans exports to Europe. Most products have to be sold locally and include:

- meat in various forms (frozen, chilled, fresh, smoked, dried [biltong]);
- salted skins;
- fat;
- feather articles such as dusters; and
- egg shells (plain, painted and carved).

Typical retail prices[2] were: smoked fillet Ksh1 000 per kg; fillet Ksh500 per kg, steak Ksh250 per kg; biltong Ksh100 per 100 g; liver pate Ksh40 per 100 g; feather dusters Ksh100 small, Ksh50 for medium and Ksh200 for large; whole feathers Ksh80-100 each; plain whole egg shells Ksh800; eggshell necklaces Ksh1 000 small or Ksh2 000 large; and oil Ksh100 per litre.

All ostrich farms must be registered with the KWS, who inspect and issue farm licences and export and collection permits. It is still possible to obtain from KWS a permit to collect ostrich eggs from the wild. A wild ostrich population count needs to be undertaken and no more than 15 eggs can be removed from a nest, leaving a minimum of two eggs *in situ*.

FUTURE DEVELOPMENTS

The Kenyan ostrich industry is gradually breaking into new markets for its birds and products. Overseas markets have yet to be fully exploited but markets do exist in Europe if the Kenyan industry can comply with EU regulations.

An Ostrich Management Plan (OMP) has been developed by KOPA, KWS and the government, which specifies the conditions under which farmed ostriches should be kept in Kenya. The OMP covers:

- the definition of farmed ostriches;
- the collection of eggs and chicks from the wild;
- the identification of birds;
- controls on imports of live ostriches, fertile eggs and sperm;
- licensing of farms; and
- the marketing of products.

SUBSPECIES AND STRAINS

The native ostrich is *Struthio camelus massaicus* (The Masai, East African or Kenyan Red-neck). It has the smallest range of any of the four ostrich subspecies and occurs naturally only in Kenya and Tanzania. This is essentially the only subspecies in Kenya, although a few East African (Somali) Blue-neck ostriches have been imported recently for trial purposes. Kenyan Red-necks do not appear to have been used in crossbreeding, either to produce the South African Black-neck or the Israeli Black-neck.

[2] Kenyan Shilling 48/= to US$1.00

The Kenyan Red-neck is a large bird, standing 2.3 m high to the top of the upright head, although it can stretch higher. Females of the four sub-species are indistinguishable and have a dull, grey-brown plumage, but the subspecies can be distinguished by the colour pattern of the males. The Kenyan Red-neck male has a pink skin on the bare neck which becomes darker red in the breeding season, but it is not as red as the North African or Sudanese Red-neck (*S.c.camelus)*. The top of the head of the Kenyan Red-neck is not bald and the white ruff of feathers around the neck is narrower and lower down the neck than that of the North African Red Neck. The scales in front of the legs and the upper and lower bill are pink. The body feathers are not as black as those of the North Africa Red-neck, but the wing and tail plumes are clean white.

The Kenyan or East African Red-neck appears to have the largest body size and fastest growth rate of all the four subspecies. At ten months of age farm-reared Kenyan Red-necks weighed 125 kg, whereas Zimbabwe farm reared ostriches weighed 100 kg and South African and Namibian farm reared ostriches weighed 70-90 kg. The Kenyan Red-neck can therefore be marketed earlier, at nine months of age, when they weigh 110 kg live weight.

MANAGEMENT SYSTEMS

The full range of ostrich management systems operate in Kenya. The Masai Ostrich Farm (MOF) has an intensive colony breeding system with 25-30 breeders in each pen. In contrast, the neighbouring Loldia Farm Ltd has a completely free-range system with ostriches living naturally on a 2 000 ha fenced property, within which they, together with other species of wildlife, are harvested by being shot.

At the MOF ostriches are fed only on formulated rations with the purchased ingredients mixed on the farm. None of the farms cultivate crops or pasture solely for their birds, and the amount of natural feed available varies from farm to farm. Feed may be placed on the ground or in containers, either specially designed to limit spillage or, more commonly, from rubber tyres split in half. Birds are fed daily with 2 kg of feed mixed with pasture chaff per adult bird. In a few cases there may be bullying of a weak bird, but generally birds eat together. Water is usually provided in plastic bins.

High security fences are an important and expensive feature, and need to be at least 2.2 m high and made of chain wire. They are designed to exclude predators such as jackals, hyenas, leopards and man. The only predator not excluded is the Egyptian vulture which may break ostrich eggs by dropping stones on them. Pen fences are usually lower (±2 m) with a 10-15 cm diameter top rail, and four strands of plain wire below. Having the top rail at eye level for the ostrich is the main criterion for effective containment. Shade is not necessary but trees which provide some shade are usually present in pens. Apart from the feeders and water containers, there are no other facilities such as races, crushes or catching pens in the yards.

The Masai Ostrich Farm keeps a 3 m perimeter strip of bare soil to prevent ticks entering the property. This is achieved by brushing and periodically disc ploughing inside the perimeter fence.

Birds display various levels of imprinting and behaviour towards humans. Some show little fear and come close, but males may be dangerous if they become aggressive in the breeding/brooding season.

BREEDING AND REPRODUCTION

Breeders are kept within the same type of pens as the younger stock. The dimensions of the pens vary from 25 x 25 m to 25 x 100 m, but the colony size is relatively constant at about 25-30 birds in a ratio of one male to two females.

Adult birds have a single breeding season in the second half of the year and most of the eggs are laid between August and October. It takes approximately three weeks for the senior female to accumulate the 10-11 primary eggs. During this period junior females may lay another dozen or more eggs in the nest. These are usually pushed out by the senior female who will not incubate them.

A variety of incubation methods are practised and include:

- complete natural nesting;
- collecting only the excluded eggs for artificial incubation; or
- collecting all the eggs for artificial incubation.

When the eggs are collected regularly females may lay up to 40 eggs, otherwise laying stops after 10-11 eggs, and incubation starts. The number of eggs laid will increase with age, and the length of lay is thought to be related also to the quality of nutrition of the female prior to, and during the breeding season.

Females will sit on the nest during the day, and the male at night. Males will chase off other males to prevent mating, and females from other nests, and destroy their eggs if possible. If a male becomes too aggressive it is are usually culled, as in many cases fertility is often poor.

Fertility varies between nests and the variability is thought to be more a feature of the male than of the female. If one female lays all infertile eggs however, she may not have been mated at all.

INCUBATION AND HATCHING

Even in intensive systems where most of the eggs are artificially incubated, clutches of eggs may be incubated naturally at the end of the season if the incubators and brooders are full. Eggs for artificial incubation are collected using gloves which are wiped with a disinfectant after every 2-3 eggs. The eggs are also wiped with a cloth soaked in $KMnO_4$ solution, and may be fumigated with formaldehyde gas prior to storage. Eggs are usually stored for a week at room temperature by placing them on a shelf of plastic foam in a shaded room. Prior to being placed in the incubator, the eggs are wiped again with $KMn0_4$ and pre-warmed to incubation temperature.

Chicken incubators are often converted to hold the larger egg, but additional heater fans may be installed to cope with the insufficient air flow. Incubators have also been made from insulated rooms into which heated air is blown; temperatures are not finely adjustable but good fresh air flow is ensured, which is considered more important than precise control of temperature and humidity. Humidity in Kenya is often too high, and some form of dehumidification has to be used,. such as air-conditioning units for the incubator room or moisture-absorbent material placed in the incubator.

Eggs may be placed on end or left on their side. They are turned slowly and gently by 90° once an hour. Egg weight gain or loss is not recorded. Eggs are candled when placed in the incubator to check for rot and to place the air sac at the top, and candled again at two weeks to check fertility. About 50 percent of eggs are fertile and 50 percent of the fertile eggs hatch.

The eggs are placed on racks in the hatching room on day 40, and when the shell is pipped they are placed on foam mats on the floor. Electric coil radiant heaters warm incoming air which is circulated by a set of four fans under the ceiling. One farm has a special hatching room to decrease the circulation of fluff in the incubator.

The claw of one of the large toes breaks the shell, ostrich chicks having no egg tooth. Chicks are not assisted from the egg after breaking though the shell; however the shell is often broken to enable fresh air to penetrate the air sac of a hatching egg. If an egg has taken two days to hatch, the chick may be helped out and the peripheral vessels tied to prevent haemorrhage. After hatching, each chick is labelled with a cardboard strip stapled around the neck to identify its breeding pen, and its navel disinfected with iodine.

BROODING

Brooding takes places in cement floored timber sheds within a dirt yard ten times the size of the shed. Newly hatched chicks are placed in heated hover brooders which are lit by incandescent bulbs, and are not fed or watered for two days. Fluctuations between day and night time temperatures are not large, but the hover can be lowered at night to provide extra warmth. Rubber and foam mats are used on all cement floors to prevent feet from slipping and any splayed legs may be taped together. All mats and floors are cleaned and dried each day.

After two days, if the weather is wet and dull, mash feed is placed on the mats and water made available in trays during the night. On fine days feed and water are placed in the outside yard, and the birds allowed plenty of running space. A small amount of fresh greens in the form of chopped spinach is provided each day.

Starter rations have a maximum protein content of 22 percent; if it is any higher than this, twisted and bowed legs have been observed. Cooked shell grit made from hatched ostrich shells is fed separately as a calcium supplement.

GROWING TO SLAUGHTER

At three months of age the birds are moved into larger outside pens measuring approximately 25 x 25 m. Groups of about 25 growers are kept in these pens until they reach slaughter weight (110-120 kg) at between 9-12 months of age. During this period they are fed a complete ration with occasional extra green feed.

The pens may be made of post and top rail, with slip rail gates. Apart from the half tyre feeders and water containers there are generally no other facilities. The yards are cleaned daily and the manure is used on the homestead gardens.

NUTRITION AND FEEDING

Feeds are mixed by local feedmills or on the farm. Some feeds contain up to 20 ingredients based on the observed preference of the birds. Most feeds however, are formulated by computer, using a linear 'least cost' program. The programs are set with moderate levels of protein and energy requirements, but with higher levels of vitamins and minerals than those used in poultry rations.

Both field dry lucerne and hay are finely milled, and incorporated as about 50 percent of the diet, with the other main ingredients consisting mainly of coarse grains, fish meal and bran. More fibre and a less dense ration is fed to older birds. It is felt that breeder rations need to be improved to improve the hatchability of eggs.

FACILITIES AND HANDLING

Once birds are used to their handlers, they do not generally panic when people come into a pen. They are however easily frightened by strange objects, sudden movements or loud noises. They react less when workers wear a uniform colour. Birds hatched from eggs from free-range parents tend to be more nervous than those from parents raised in closer confinement.

Birds need to be caught for various reasons and this is done in the yards. Individuals are herded into a corner where two men stand beside each leg, holding the bird under the abdomen and on top of the tail. A neck crook is used to pull the head down, and the lower bill is held down at knee level with the thumb inside the lower jaw. This prevents the bird striking forward with the feet. The bird is held in this position for treatments such as tagging, oral dosing, injecting, blood sampling, and examining and treating for external parasites. Crushes are built on some farms, but they are not universally favoured as they can damage skin and feathers.

Identification is by microchip, preferably in the pecking muscle at the back of the neck, or by cattle ear tags clipped to a fold of neck skin, or by hock tags.

When being transported, birds may have to be forced from behind up the loading ramps into the trucks. Adult birds need trucks with 2.2 m high sides with a canopy of hessian or canvas to prevent heads and necks hanging out. The truck floor is usually covered with sand, soil or grass, and the side walls covered with grass filled sacks to limit damage to feathers and skin. Sections are also placed inside trucks to divide the birds into groups of six, as this helps to prevent birds being thrown off their feet and trampled.

SLAUGHTER AND PROCESSING

Slaughter using a captive-bolt pistol results in a large amount of paddling by the bird, which is potentially damaging to the bird itself and to others. A controlled procedure used on the Masai Ostrich Farm consists of making the bird squat on a length of canvas which is then strapped over the back of the bird to restrict the movement of the legs. The bird is made to squat by swinging the head around until it is giddy. After stunning, the bird is bled out while lying on a plastic foam filled mattress, where it is plucked by hand.

The lower legs are cut off at the hock joint, and the carcass is hung by the hocks on a spreader which stretches the legs apart. The skin is cut down the centre ventral line and along the inside of the wings and legs; it is then removed using a curved skinning knife. Care is required not to cut through the skin, especially in the follicular (bulb) region over the back. The subcutaneous fat is cut off and the bird is eviscerated, washed, and sawn in half down the backbone into two sides ("legs"). The sides are cut into fillets, steaks and off-cuts, or smoked and sliced and then vacuum packed and labelled. Some cuts are dried and sold as biltong.

The skins, once removed, are immediately identified with a non-removable tag and washed in cold brine before being transferred to fresh cold brine for an hour. They are then stacked on top of each other in a box with a raised centre, follicle side down, and the upper (flesh) side covered with a mixture of coarse salt, boric acid and naphthalene. These are left in a refrigerator for one week while water drains off. The salt is then brushed off and the skins rolled with the flesh side inside, and packaged into brine soaked hessian bags which are kept damp in the refrigerator. They are stored in this manner until sent to a tannery.

Feathers are sold on the open market without any restrictions. Eggs for sale are stamped with the farm and egg code number; a sale register must to be kept.

The following are sample weights of body parts from a 10-11 month old female Kenyan Red-neck ostrich.

Table 9
Weights of Body Parts of Kenyan Red Necked Ostrich (10-11 Months)

	Weight (kgs)	Percent
Total live weight	125.0	100.0
Chest and wings	10.0	8.0
Back and legs	47.0	37.6
Lower legs (shins)	4.25	3.4
Neck	2.8	2.2
Head	0.75	0.6
Stomach and intestine	17.5	14.0
Gizzard	2.0	1.6
Heart	0.9	0.7
Liver	1.5	1.2
Food and stones in gut	6.5	5.2
Fat (around body)	5.5	4.4
Skin	6.5	5.2
Tail	0.25	0.2
Feathers	1.5	1.2
Total dressed weight	57.0	45.6

Note: weight of blood not included

DISEASES

The Kenyan Red-neck is considered very hardy and relatively resistant to disease. Cattle ticks are present in Kenya, and infest both domestic and wild animals including the ostrich. Ostriches will eat ticks; nevertheless birds must be passed free of ticks for the farms to be approved for the export of live birds to the United States of America. Two tick control measures are commonly practised:

- Birds are sprayed with an acaricide two to four times in the non-breeding season.
- A physical barrier is constructed consisting of a double fence-line around the farm, with 3-6 m harrowed gap between the fences.

Birds are also checked for lice and treated with insecticidal sprays where necessary. Faecal examinations determine levels of internal parasites such as tapeworms and roundworms, which are controlled with anthelminthics.

The Veterinary Diagnostic Laboratory and the Veterinary School have not isolated Avian Influenza (AI) virus from cloacal swabs, or antibodies from blood samples; birds are not therefore vaccinated against AI. There are occasional outbreaks of mesogenic strains of Newcastle Disease in indigenous poultry in Kenya, but none has been detected during 1993-1996.

Chapter 5
Ethiopia

BACKGROUND

Formerly known as Abyssinia, Ethiopia lies within the horn of Africa and is bordered by Eritrea and Djibouti to the north, Somalia to the east, Kenya to the South and Sudan to the west.

The country covers over one million km^2, and has a high central volcanic plateau dissected by the Rift Valley running from the north-east to the south-west. Rivers radiate out between the mountains to the north-west and provide most of the water for the Blue Nile and the White Nile. Two large river systems arise on the central plateau and drain to the south-east. The Rift Valley itself is drained to the north east by the Awash River and to the south-west by the Omo River.

The climate, soil and vegetation of Ethiopia changes from one extreme to the other, depending on the topography. The central plateau (2 000 to 4 000 m) has a cool climate and good rainfall. The Rift Valley lies at about 1 500 m and is much hotter and drier than the surrounding mountains. The lower eastern and south-eastern regions are hot, dry deserts, while the western and southern-western regions are hot and humid and covered by rain forest. The rainy season is from June to October.

In 1974 Emperor Haile Selassie was deposed by his own military. In 1991, the military leader, Mengistu Haile Maryam, was replaced by a transitional government of 87 representatives led by Meles Zenawi. Since 1991 the Meles Zenawi multi-party government has based Ethiopia's economy on a market footing. Progress is slow however, as both the agricultural and industrial sectors started from a very low base.

There are nine administrative regions and each region consists of a number of districts. The smallest region is the capital, Addis Ababa, which lies at the centre of the country at 2 300 m, the third highest capital in the world. The policy of regionalization is giving increasing autonomy to the regions.

The population is approximately 53 million, growing at over three percent per year, and consists of more than 70 ethnic groups. Only a small proportion of the population lives in the cities and towns. The livelihood of the majority of the rural population is livestock-based. Work oxen are particularly important for cultivation, and donkeys are also important for transportation. In addition, the majority of households keep backyard chickens, and sheep and/or goats. Even in the rainy season, water is in short supply in most areas, and water collection is a time consuming task.

Ethiopia is the natural habitat of two of Africa's ostrich sub-species. The north-west of the country is the southern limit of the North African (Barbary or Sudan) Red-necked Ostrich (*Struthio camelus camelus*) while the south and east of the country is the northern limit of the East African Blue-neck Ostrich (*S.c.molybdophanes*). As ostriches are native to the semi-arid environments of Ethiopia, they are a suitable species on which to base a sustainable animal production system.

THE HISTORY OF OSTRICH FARMING IN ETHIOPIA

Ostriches occur wild in the Yanguri Rassa National Park, Alidaghe Reserve, Yabello Sanctuary and the Oman and Mago National Parks in the south-east and south of Ethiopia.

Ostrich farming in Ethiopia was commenced in 1984 by officers of the Ethiopian Wildlife Conservation Organisation (EWCO) in two national parks caring for ostrich chicks captured from the wild. The Abijata-Shalla Lakes National Park (ASLNP) was given three juveniles (two male + one female) captured at Mega in Southern Borena Zone in 1984 and a further 16 in 1985. Staff of the Awash National Park (ANP) captured ten chicks at Alidaghe in April 1985 and all the birds at ANP had been transferred to ASLNP by March 1986. A one km^2 area of the ASLNP park was fenced off for the ostriches and it was given the name "Langano Ostrich Farm" (LOF).

The location at the Abijata-Shalla Lakes National Park has a number of physical disadvantages. The climate is wetter than the more southern and eastern regions from which the birds originate, and there is a high early chick mortality, due to their susceptibility to hypothermia when wet. The high density of trees, thick bush, barbed wire fences and high stocking rate all pose serious problems for the birds, and collision accidents, sometimes fatal, are common.

By 1986 there were 29 ostriches on the farm and the aim was to market the skins of 14 month old birds. Ostriches continued to be captured and some chicks were hatched by the adult birds. By May 1991 there were 89 birds on the farm. In May 1991, during the unrest, a new ostrich farm which was being built 18 km to the north of ASLNP headquarters, was destroyed and the birds at ASLNP were released. Almost all ostrich chicks were either killed by dogs or by accidents.

A year later, 56 birds (33 male, 21 female and 2 juveniles) were recaptured and moved into a rehabilitated five km^2 fenced area. During the following year 18 of these died, due mainly to colliding with trees and cars, and other accidents.

In March 1993, after regionalization of the government, the Langano Ostrich Farm came under the control of the Oromia Natural Resources Development and Environment Protection Bureau (ONRDEPB). At that time there were 38 ostriches (26 male and 12 female) on the farm. A study in 1994 of the nesting behaviour of the ostriches on the farm was undertaken by Theresia Staaland (1996). At that time there were 36 birds (25 male and 11 female), all over three years old, indicating that no chicks had survived from the previous two seasons. The Oromia regional government was unable to obtain funds from the central government to support the farm, and it was recommended that it be sold to a private organisation. No buyer however could be found, either for the live birds or for the products that could be obtained by slaughtering the excess male birds.

In May 1995 an internal report indicated that there were 40 birds (24 male, 10 female and six juveniles. The numbers had increased by September 1996 to 45 birds, of which 32 (18 male and 14 female) were East African Blue-necks (*S.c. molybdophanes*) and seven (five male and two female) were North African Red-necks (*S.c.camelus*); in addition there were six chicks that were six years old.

Ostriches survive on the local food resources in Ethiopia without apparent damage. In spite of its chequered history, ostrich farming in Ethiopia could be a viable enterprise and continues to be of interest to the Ethiopians.

CURRENT STATUS OF THE OSTRICH INDUSTRY[1/]

Prior to the change in government in 1991 the Langano Ostrich Farm at the ASLNP was being actively developed. A new set of farm buildings and yards were being completed, an incubator had been purchased and the first two ostrich skins had been tanned at the Mojo tannery and made into jackets. These facilities were destroyed or stolen during the 1991 disturbances and funds were not forthcoming to rehabilitate the farm. The farm is once again in an early development phase.

The Langano Ostrich Farm has had little investment put into fences, sheds and equipment. The infrastructure consists only of the surrounding wire fence, and there is no internal fencing. There is an isolation pen with a wooden shelter, which is alternately used to isolate excess males in the breeding season, and parents and chicks in the brooding season. There are no artificial incubating or brooding facilities and the parent birds incubate, hatch and brood the chicks. There are no feed mills although there is a forage chopper for cutting up green feed. Half tyres are used as feed and water troughs. Maintenance is cheap: feed costs are low as the birds browse on the local vegetation and labour requirements are minimal. Development was static as the Government had not approved funding for an incubator or the sale/slaughter of the excess male ostriches.

FUTURE DEVELOPMENTS

Government supports the idea that creating ostrich farms should be undertaken only in the semi-arid, rangeland areas of the country which are the natural habitat of the two native ostrich subspecies. These areas are also home to nomadic ethnic groups who make their living almost exclusively from livestock. Ostrich farming may offer a more lucrative supplement to the existing livestock production systems, especially for those wishing to settle in one place.

If more ostrich farms were to be established they would probably need to be low cost extensive enterprises, and thus unique: in most countries ostrich farming is capital intensive with high operating costs. Any significant short-term expansion of ostrich farming in Ethiopia seems unlikely. In the longer term, the development of an ostrich industry in Ethiopia will be depend on a number of factors, notably:

- the development of domestic and export markets and the necessary processing infrastructure (the tanning industry is already well developed in Ethiopia);
- the development of effective producer associations; and
- access to land, knowledge and skills and support services, such as credit, extension and research.

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[1] 1996

Development options proposed for future of the Langano Ostrich Farm, which should also function as an education and training centre if it remains in the public sector, are that:

- The farm size should be increased to one km^2 per breeding male, or the number of breeding males reduced accordingly.
- Each male with his senior mate should be fenced into separate 25 x 25 m incubation/ breeding pens each with a small (5 x 5 m) entry/exit/feeding and catching pen.
- An acacia clearance programme should be initiated.
- A programme should be drawn up to fence off dangerous holes and gullies caused by erosion and subsidence.
- An applied research programme should be reinstated.

The products with the greatest potential to develop a viable industry are live chicks and the skin. If clean undamaged skins can be produced and tanned quickly, the hides could enter the international leather market at attractive prices. There is little demand for feathers. To develop an export market for meat poses numerous problems, notably:

- a need for export standard abattoirs;
- installing packaging and freezing equipment;
- ensuring that slaughterhouse attendants can meet the standards of hygiene and quality control required by the market; and
- ostrich meat can be obtained cheaply from South Africa.

Canned beef is popular in Ethiopia and ostrich meat could be processed by the existing canneries, although the return from this market would not be high.

SUBSPECIES AND STRAINS

Ostriches are present in large numbers in the grassland regions to the north east and south east of the country. It is estimated that the total East African (Somali) Blue-necked Ostrich (*S.c. molybdophanes*) population in this region is several hundred. It is the tallest of the four subspecies, has an almost bald crown on top of the head and a wide white line of feathers at the base of the neck. Its skin is a dark blue, darker than the South African Blue-necked Ostrich (*S.c.australis*). It is suitable for farming and, if controlled by fencing and supplied with water from the Awash River, would provide with a more secure livelihood.

The southern extremity of the range of the north African (Sudan or Barbary) Red-necked Ostrich (*S. c. camelus*) extends into the western half of Ethiopia, and although this subspecies was used to infuse good feather characteristics into the South African Black-neck, the population is not large. It is also a large bird with a bald crown and its skin is red and appears to be sunburnt. No crossbreeding between *S.c. camelus* and *S.c. molybdophanes* has occurred under natural conditions on the Langano Ostrich Farm, even though the birds associate with each other and lay in the same nests.

The eggs of these two subspecies can be easily distinguished. Those of the *S.c.molybdophanes* are smaller, narrower in shape and lighter than those of *S.c.camelus*. The surface appearance differs considerably, those of *S.c.molybdophanes* having matt white shells with large prominent pores on the surface, and those of *S.c.camelus* having yellow shiny smooth shells without visible pores.

There is a real need for a detailed comparison of all production aspects of these two subspecies under present market conditions. Ethiopia is the only country where they occur naturally and have been farmed together without interbreeding. At the ASNP farm there appear to be no obvious advantages of one subspecies over the other, except that the skin of *S.c. camelus* males appeared to be more easily damaged (scratched, torn). This may be simply a reflection of the smaller number of *S.c. camelus* rather than an intrinsically weaker skin. Some other production aspects that need to be examined include: clutch size, number of clutches per year, age of sexual maturation, breeding season and duration, triggers for mating and egg laying, fertility, hatchabilty, territorial behaviour, ease of brooding, growth rate, diet preference, carcass composition, product yield and quality, and disease susceptibility.

BREEDING AND REPRODUCTION

In the 1994 breeding season (Staaland 1996) 9-16 males were confined in the separate enclosure in the middle of the Langano farm. Of the free-range males, eight were territorial. Five nests were initiated and both *S.c. molydophanes* and *S.c.camelus* birds laid in the same nests. A total of 129 eggs were laid, but only one nest belonging to an *S.c. molydophanes* male and an unknown female completed the full incubation. Performance in 1996 was worse: of the 90 eggs laid in five nests only 11 chicks hatched - a hatchability rate of 12 percent.

Although *S.c. molydophanes* and *S.c.camelus* adults associate with each other and will attempt to crossbreed, no successful crossbreeding has occurred. It has been observed (Wandimu pers. com., 1996) that the kantling number is different for the two subspecies and that although both will squat to mate, the subspecies with the shorter kantling number stands up before the other is ready for mating.

INCUBATION, HATCHING AND BROODING

During natural incubation the male sits on the nest from the afternoon until the following morning, and the female sits during the daylight hours. Eggs continue to be laid in the nest during incubation and some eggs are moved out of the nest by the male and senior female.

In the one nest that was successfully incubated in 1994, 12 eggs (8 *S.c. molybdophanes* and 4 *S.c.camelus*) were moved to the edge and 23 eggs were incubated. Of these, nine were hatched naturally, two required human assistance, four were dead in shell and the rest (eight) were considered infertile. The fertility rate for the incubated eggs was 65 percent with a hatchability of 48 percent. The hatchability of fertile eggs was 73 percent, but for the total nest of eggs the hatchability rate was 31percent. The adult birds left the nest with the surviving hatched chicks five days after the first chick was hatched, but after that day three more chicks hatched and were successfully placed with the other chicks.

Hyenas and jackals posed a problem and LOF staff had to camp close to the nests to protect the eggs and baby chicks.

No records, except for mortalities, were kept regarding natural brooding behaviour or growth of the birds raised at Langano Ostrich Farm.

NUTRITION AND FEEDING

Birds at the LOF fed on the young leaves and pods of thorn tree *Balanites aegypticus,* and the seeds and seedpods of various *Acacia spp.*, as well as young grass. Young birds also ate the faeces of older birds. When supplementary feed was given, it consisted of wheat bran and ground maize for older birds or ground barley for chicks.

No estimate of the nutrient content or quantity of feed eaten by the birds has been undertaken. The feed was placed into half tyre feeders near the entrance to the farm in the afternoon. Birds congregated near the feeders and many were tame enough to be photographed while being held by visitors to the farm. Water was brought to the farm by tanker and dispensed daily into a water troughs.

SLAUGHTER AND PROCESSING

Although there have been no sales of live ostriches from the ASNP farm, some experience has been gained in the preparation and marketing of ostrich products. In 1992 two ostrich skins were wet salted and taken the Mojo Tannery where they were tanned and later made into leather jackets. The meat was consumed locally and no feather or oil products were harvested.

The only product sold from the ASNP ostriches are the eggs. These could be decorated and sold for up to 300 Birr each; however all eggs available for this purpose were still in store waiting to be sold. The number of eggs available however depends on the number of eggs laid and the proportion of those that are not hatched or broken. If the husbandry practices improve, more eggs will hatch and fewer will be broken; the income from the live chicks would be much greater than that from plain or decorated eggshells.

DISEASES

Breakage of eggs, abandonment of nests, unhatched eggs and death of chicks after hatching has led to large losses on the Langano farm. There are no records of cause of death of chicks less than one week old. Post-mortem records indicate that since the end of 1990, ten chicks less than six months old died of disease or trauma such as broken legs, and three yearlings (9-12 months old) died of the same causes. Ten adults (four male and six female) died, seven of trauma caused by colliding with Acacia trees or falling into holes, and three from disease.

The data indicates that the major causes of loss are the abandonment of nests and physical injuries, which account for approximately five percent loss per year, while disease accounts for approximately another five percent per year.

Data from Kenya (Bertram,1992) on the home territory of of *S.c. massaicus* breeding males would indicate that the one km^2 farm at Langano is only sufficient for one or two male breeding territories. The dominant male will not only chase other males off his territory but also females (other than those with whom he shares a nest) off their nests, possibly destroying their eggs. It appears that overstocking at LOF is the main factor responsible for the abandonment of nests and the consequent low hatchability of eggs over the last ten years.

A number of lessons can be learned from these results:

- In a completely free-range operation each male should be allowed at least a 1 km^2 breeding space, otherwise breeding pairs should be confines to a fenced area;
- Fences should not be made of barbed-wire.
- Ostriches should be kept away from in areas with steep cliffs or holes.

Chapter 6
United Arab Emirates

BACKGROUND

The geography, history, politics and culture of the United Arab Emirates (UAE) have a bearing on development and on the possible growth of the ostrich industry in the Emirates. The UAE is a country of 83 600 km^2 in the Arabian Peninsula and is surrounded by Saudi Arabia on its western and southern borders, Oman on its eastern border, and Iran on the opposite side of the Persian Gulf. To the east are the Hajar mountains and to the south and west to the deserts of the "Empty Quarter". Along the Gulf coast there is a string of 200 islands.

Cropping occurs in the east in the foothills of the mountains where forests can also be supported. To the west and south however, the vegetation becomes more sparse until the land turns to sandy desert with occasional oases.

In the past, the Arabian Peninsula physically linked Africa and Asia, and the area would have been grasslands with a more substantial rainfall. With the formation of the Red Sea and the Arabian Gulf, the climate became drier and with sparse vegetation. The present climate is hot and humid with summer (June-September) temperatures over 50°C.

The origins of the people are nomadic Bedouin and many still live in tents in the desert, tending camels, goats and sheep. Prior to federation in 1971, the Emirates were independent countries ruled by an Emir and were collectively called the "Trucial States". With federation they took the name of the United Arab Emirates. There are seven Emirates: Abu Dhabi, Dubai, Shajah, Ras Al Khaimah, Fujairah, Umm al Qaiwain and Ajman, each with a capital city of the same name. Abu Dhabi and Dubai are both far larger than the rest put together and therefore dominate the UAE politically. At the time of federation in 1971, the population was 180 000 but by 1996 it had risen to 2.2 million, boosted by the influx of expatriate workers.

Oil was discovered in 1958, and now flows at 2.5 million barrels a day, making the UAE the fourth largest oil producer in the world with an annual income of US$ 37 billion in 1994. Prior to the discovery of oil the country was poor and the local people had to work hard for a living. Now the indigenous population consists of closely related ethnic groups which are generally wealthy and do not need to work.

Wealth has physically transformed the country, which now has modern infrastructure, communications and services. Health care, education and social welfare are universal and free. Many of the Bedouin now live in apartments and villas. The economy is open and there are no trade restrictions or import and export duties. Apart from oil, the country is now also a major exporter of dates.

A start has also been made at farming animals. Breeding farms for camels have always been present, but farms with chickens, beef and dairy cattle, sheep and goats are now emerging. Private wildlife parks are flourishing but, unlike the livestock enterprises, are not run on a commercial basis. Well-funded animal research and breeding centres have been established and are expanding their role in the conservation, regeneration and management of the UAE's natural resources.

THE HISTORY OF OSTRICH PRODUCTION IN THE UAE

An extinct sub-specie of ostrich (*Struthio camelus syriacus*) used to live in the Arabian Peninsula, but the present breeds of ostrich in the UAE are reported to have come from South Africa, Ethiopia and Zimbabwe several years ago.

In Dubai, Sheik Butti purchased ostriches around 1992 to add to his wildlife collection. Later, in 1995 he ceased farming cattle, sheep and goats in order to establish commercial ostrich production based on his wildlife park birds. The Sheik employed a specialist in ostrich production and imported 15 young ostriches from Zimbabwe, with plans to import South African Black-necks to broaden the genetic base of his flock. Sheik Butti's cousin and brother-in-law Sheik Mohammed also has two small breeding groups of five birds each in Dubai.

CURRENT STATUS OF THE OSTRICH INDUSTRY[1/]

Because of the open trade policy there are no import restrictions or taxes to stop the import of live ostriches or ostrich products. In fact, ostrich meat imported from South Africa is widely available and is on the menu of many hotels in UAE. There are minimal quarantine requirements since the only disease of major importance is Newcastle Disease, which is endemic in the UAE.

Much of the land is controlled by. the hereditary Sheiks; however, the local municipalities control the sale of land, so farmland can be purchased. A number of smallholdings exist around each major population centre producing crops and livestock for local consumption. Ostrich farming could in theory be undertaken by anyone who could obtain ostriches, but ostrich prices are high, the birds too valuable to slaughter and there is insufficient yield of feathers to make feather production worthwhile.

The reality is that ostrich keeping remains the domain of the wealthy investor who can afford the investment in fences and shelter. Sheiks have the economic advantage of not having to pay for water or veterinary diagnostic work, and labour costs are not as high as those in Europe. The few ostriches in the country are kept by a few of the top sheiks in each Emirate and the total ostrich population in UEA probably does not exceed 50 breeding adults. Furthermore, the majority of these are kept in wildlife parks and not on commercial farms.

In Dubai, Sheik Butti has a keen interest in animals. As well as keeping a few ostriches on his large wildlife park, he has also commenced farming ostriches at two separate locations using three and four adults respectively.

[1] 1996

In the wildlife parks and zoos the birds are largely left to scavenge for food and breed naturally. On the few ostrich farms good facilities are provided but numbers are small and rapid progress is not expected.

FUTURE DEVELOPMENT

In the short-term, ostrich production could make further gains through the application of basic husbandry techniques, namely:

- reducing the reducing the breeding ration from 1:3 to 1:2 or even1:1 which will increase fertility per hen;
- improving the nutritional status of all birds, especially those prevented by competition from getting adequate feed; and
- replacing the older males brought from the wildlife parks with younger males.

In the longer-term it is planned to import live birds from Africa and Australia. This will broaden the genetic base and strengthen the gene pool and it is expected that the genetic lines will show improvements in production parameters within two or three years.

SUBSPECIES AND STRAINS

The subspecies found in the UAE are: South African Blue-neck (*Struthio camelus australis*) and East African Red-neck (*S.c.masaicus*). Both of these are wilder, less domesticated than the smaller and quieter African Black-neck, which is a cross between the South African Blue-neck and the North African (Sudanese) Red-neck (*S.c.camelus*).

There has been virtually no breed improvement or selection for desirable characteristics undertaken in the country, although old, infertile and lame birds are culled. Females are not selected for earlier egg production, since this would mean that eggs would be laid in the hottest period when it is more difficult to incubate both naturally and artificially.

ENVIRONMENTAL AFFECTS

Heat and humidity stress birds during the summer. The hottest months are June to August when the coastal areas are also extremely humid (up to 90 percent relative humidity). Away from the coast it is less humid and although the temperature is usually higher it does not create as much heat stress.

When their body temperature is high, ostriches will pant and spread their wings to cool down. Birds will also seek shade, so shelters and shade trees are provided as well as water sprinklers and wading ponds. One farm has sprinklers attached to the top of the shade roof posts which are turned on for five to ten minutes four times a day, and the birds will stand in the ponds for hours at a time. Both of these facilities appear to be effective cooling aids.

The hot dry sandy environment means that internal parasites are not a problem in ostriches in the UAE.

BREEDING, INCUBATION, HATCHING AND BROODING

Breeding groups of two to four hens per male are often placed separately into a smaller pens. With the higher male to female ratio, the male may not mate with all females. In this case it is necessary either to decrease the ratio to 2:1 or to leave breeding groups together longer. When more birds are available it is intended to experiment with different group sizes such as pairs, trios and larger colonies to try to increase the number of progeny. No artificial insemination has been attempted.

With natural incubation, females lay only one clutch of about 15 eggs. When eggs are collected daily for artificial incubation, three or so are left in the nest to encourage laying. Up to 100 eggs may be laid in one season. The average however is about 40 eggs per hen because of lower production from young and old birds.

At the start of the laying season it is usually too hot and humid for successful natural incubation and eggs are artificially incubated. In the more humid areas eggs may also be lost due to bacterial infection entering through the pores. Later in the season, when the weather is cooler and less humid, natural incubation is more successful. This is also the time when incubators are full if the egg-laying season has been good.

When the air temperature is above the required incubation temperature, incubators are cooled by circulating cool water through copper pipes. Cooling may also be required in the hatchery as the chicks generate considerable body heat.

Eggs are placed on their ends and held in position by a spring tensioned wire frame. Trays are tilted to a 45 degree angle and moved 90 degrees each hour. Eggs are candled half way through incubation and placed with the air sac at the top, and any infertile eggs are discarded.

When artificially reared, chicks are kept indoors in a controlled environment for at least three weeks to prevent exposure to the elements, predators and fibrous vegetation. The major cause of chick mortality is impaction due to the ingestion of fibrous material and sand. After three weeks chicks are allowed out into yards, and eventually into yards without shelter.

MANAGEMEN, NUTRITION AND DISEASE

Yards and Handling

Yard fences are approximately two metres high and made of chain link attached to posts at two metre intervals. Artificial shade (3 x 3 x 3 m) is constructed of hessian or green painted corrugated iron sheets and at least one shade tree is provided in the yard.

Some farms use concrete troughs placed on the fence line which are divided to hold both water and supplementary feed. A small pond, approximately 0.6 m deep and 3 m in diameter, may be provided for wading. A small enclosure, approximately 3 x 3 m, may be constructed in one corner of the yard in which to capture birds, although very little handling is practised.

Nutrition

The availability of water is the main criterion in locating an ostrich farm. Pelleted feed, which is fed *ad libitum*, and all other requirements are brought in. Irrigated lucerne may be grown and cut and fed fresh daily. Vitamin and mineral supplements and antibiotics are available and administered in the drinking water when required.

Diseases

The major causes of loss are infertility and low hatchability, predation of chicks and impaction of proventriculus and gizzard.

Chapter 7
Australia

BACKGROUND

Australia is an island continent of almost eight million km^2 and a population of 16 million that lives mainly along the eastern coastal strip. The land is relatively flat with border ranges inside a narrow coastal plain to the east and south. The central plateau slopes gently towards Lake Eyre: in the centre. Surface water rarely runs into Lake Eyre: most of it seeps underground and joins the artesian basin which has sufficient pressure to force the water to the surface through drilled boreholes. The water however tends to be salty and is used for livestock. Rain falls in summer in the northern half of Australia and in the winter in the south.

The total biomass of natural vegetation is greatest on the coast plains and ranges but is almost absent in the central stony and sandy deserts. The coastal plains and border ranges receive sufficient rain for agricultural production but it declines to virtually zero in the centre. Extensive production of cereals, pulses and grazing of sheep and cattle is practised on the inland side of the ranges.

Ostriches can live in all parts of Australia except for the central desert. Ostrich farms however are found more in the eastern coastal region and the ranges than further inland because of the freight distances involved.

THE HISTORY OF OSTRICH FARMING IN AUSTRALIA

The Zoological and Acclimatisation Society of Victoria imported two male and three female immature ostriches, presumably from South Africa, in 1868; these were bred in western Victoria (Wimmera district) and their feathers sold for a high price. In the 1870s and 1880s ostrich farming commenced in South Australia using both Australian bred birds and birds imported from South Africa. In 1887, the South Australian government granted 5 000 acres of 'unproductive' land to anyone who could place 250 one-year old ostriches on it. One such property near Port Augusta had a flock of 700 birds in 1890. A number of ostrich farms were developed in New South Wales in the 1900's with individual farms of up to 550 birds. In 1912, the Yanco Agricultural Experiment Farm in New South Wales imported 12 Sudanese ostriches from North Africa.

In 1914 the industry collapsed, and many ostriches were released into the wild or transferred as tourist attractions to wildlife parks and zoos. It was not until the late 1970s and early 1980s that a group of Australian farmers began farming wild ostriches again and formed the Australian Ostrich Association (AOA). By 1992 there were 800 farmers with 6 500 birds, 60 percent of them in Victoria and in 1993 there were estimated to be 8 000 birds on ostrich farms in Australia.

CURRENT STATUS OF THE OSTRICH INDUSTRY[1/]

The majority of ostrich farms are now in Victoria, which has a cool temperate climate with a rainfall of over 600 mm per year. The rest are found mainly on the western side of the Great Dividing Range, in a belt parallel to the east coast extending from Victoria to southern Queensland.

The majority of ostriches in Australia are owned by financial investors and managed by farmers for an agreed management fee. The Australian ostrich industry is, however, highly centralized and well organized. The Australian Ostrich Association (AOA) is the only organization of ostrich farmers with offices and lobbyists in Canberra.
It has undertaken a wide range of services for members, from the production of information brochures and publication of a magazine, to the holding of annual conferences and sponsoring research. There have been a number of trial slaughters, mainly of cull birds, to assess the yield and quality of products. Companies have been established to construct abattoirs and market ostrich meat and skin. The AOA also formed its own marketing company, the Australian Ostrich Company Ltd., (AOC) in 1996. An ostrich industry group has taken an equal 40 percent share in an emu industry group to build a ratite processing facility in Victoria.

The industry is still in the multiplication stage and in 1996 adult breeding stock and fertile eggs were imported into Australia through two quarantine stations. The price of ostriches is high but falling rapidly because the demand for live birds is being met. In 1997 it was still not profitable to slaughter birds but as the price of breeding birds falls, this situation will change.

Meat from the trial slaughters has been marketed through selected restaurants in Australia and also through a distributor in the USA. A brochure has been produced to satisfy both the domestic and international markets, and the National Heart Foundation has given its seal of approval to ostrich meat as a health food. Skins from the trial slaughters have been tanned in Australia and sold overseas.

There is almost no legislation controlling ostrich production, unlike the native ratite (emu), since the ostrich is a not considered an indigenous specie and thus subject to the nature conservation regulations. Codes of Practice covering the welfare, transport and slaughter are being developed to guide the ostrich industry.

FUTURE DEVELOPMENTS

Short term

The AOA levies its members A$350.00 per year and has established a Market Development Plan and a Research and Development Plan. It also runs an Ostrich Flock Register, which records genotypic and phenotypic traits of Australian breeding ostriches. Data is being gathered on live weight gain, and leather, meat and feather quality.

The Market Development Plan predicted the commercial slaughter of ostriches in Australia by the mid 1990s. Local and export sales are planned and product specifications

[1] 1996

are being drawn up, including for value-added products. Total Quality Assurance programmes are being designed to ensure customer satisfaction. Apart from the main products of meat and leather, the industry intends to market ostrich oil and feathers. There have also been enquiries for blood, sex organs, livers, hearts, sinews, beaks and toes.

Farmers are encouraged to be highly selective in their choice of breeding birds and to sell their culls to the AOC for slaughter rather than as breeders. Three thousand birds are required over the next 12 months (1997) and it has been suggested that farmers should supply 10 percent of their slaughter age stock for this purpose (Dale, 1995a, b).

Long term

The longer-term aim is to:

- increase the supply of birds for slaughter;
- develop the necessary abattoirs, skills and techniques to ensure maximum yield of high quality exportable products;
- build confidence in the market that the Australian industry can reliably supply a high quality product; and
- continue to select and breed birds for desirable characteristics.

Other developments envisaged include:

- segmentation of the industry to specialize in breeding, hatching, growing and/or finishing for slaughter;
- combining of ostrich and emu production, but breeding at slightly different times in the year;
- integration of ostriches with other farming ventures such as deer, cattle, sheep, goats and tree crops;
- developing rations for both fast and slow growth; and
- developing mobile abattoirs so that birds can be slaughtered on site to reduce stress and also the weight loss due to shrinkage of up to 20 percent which can occur during transportation.

SUBSPECIES AND STRAINS

The ostriches that were introduced from South Africa in the 1860's are assumed to be the domesticated ostrich strain at that time *Struthio camelus domesticus.* In 1912 twelve Sudanese Red-neck ostriches (*S.c.camelus)* were imported into New South Wales and crossed with the South African strain already there. Interbreeding of the feral population produced the Australian Grey-neck. Adult African Black-neck ostriches and fertile eggs were imported from Canada in 1966. Other imported from Zimbabwe and Namibia consisted of a high proportion of South African Blue-neck (*S.c. australis*).

It is likely therefore that the Australian ostrich population is a mixture of *S.c. camelus* and *S.c.australis* but does not have any component of *S.c.molybdophanes* (Somali Blue-neck) or *S.c. massaicus* (Kenyan Red-neck). Very little selection has occurred in the Australian flock to enable different strains to be distinguished but the new Ostrich Flock Register aims to identify both closely and distantly related breeding lines.

BREEDING AND REPRODUCTION

Breeding starts when females are two years old and males are two and a half to three years old. Pairs and trios are the most common groupings in a breeder paddock. Where only pairs are kept on a property they may be left together all year, otherwise all the birds may either be placed in the one paddock, or the sexes separated out of sight of each other in the non-breeding season. Sexes are placed together at around the beginning of July and observed for pairings. The resulting pairs or trios are then placed in separate pens and given breeder diets.

First eggs are expected in August and sexes are not separated until the end of the following April. Some farms separate sexes after a specified number of eggs are laid usually 40-60 for first season hens, and 60-80 for second season hens. Prolapses and oviduct infections occurring late in the breeding season are thought to be due to an overextended laying season. Male and female pairings are changed if the eggs are not producing chicks and care is taken to try to prevent male aggression towards a new female.

The paddocks are of various sizes but typically 100 x 40 m (4 000 m^2). Fences are usually 2 m high and made of square ring-lock mesh with a 50 cm gap at the bottom for access and escape. Many new farms do not have handling facilities but those which do have a small corner catching pen measuring about 4 x 4 m, and feed is used to attract birds into the pen. Suitable nest sites are prepared on higher damp-free ground by digging out an area of 2 x 2 x 0.5 m and filling it with clean coarse sand.

Male aggression during the breeding season varies and very aggressive males are usually culled. It is recommended that breeding pens have a visual barrier of trees between them to prevent males fighting. Various strategies can be used to combat aggression, such as:

- using a tall stick or holding the hand over the head so as to be taller than the bird;
- using a crook or forked stick to control the neck of the bird;
- distracting the bird by a second person; and
- using handlers and egg collectors known to the birds.

There are no fixed recommendations for either quantity or quality of breeder diets which are varied to suit the needs of the bird. Mixed rations are usually about 15 percent crude protein and fed at 1-2 kg per bird per day. Green supplements usually consist of either lucerne or pasture and birds are given about 2 kg of fresh material daily. Vitamin and mineral supplements may be given along with an additional calcium source such as shell grit. The aim of feeding in the non-breeding season is to adjust for any weight loss or gain.

INCUBATION AND HATCHING

Almost no natural incubation is practised in Australia except at the end of the season when incubators are full, or to allow birds to stop laying.

On small farms eggs are collected shortly after they are laid, but larger farms collect once or twice a day. Hands are washed before collection or gloves are worn. Some farmers wash the eggs but usually they are allowed to dry and brushed clean. Storage is for 1-10 days in temperatures between 15-18°C; storage rooms are shaded from the sun or air-conditioned. Some farmers weigh the eggs to calculate the weight loss during storage, and the date and parentage of the eggs is written on the egg. Eggs are set in the incubator weekly and are usually pre-warmed in the incubator room..

Initially farmers converted old chicken incubators to hold ostrich eggs but these gave variable results and required special management. Now specific ostrich egg incubators of various capacities are available but require a controlled environment. Old buildings require the installation of dehumidifiers, air conditioning, insulation and controlled ventilation. Incubators are set at a temperature between 35°-36.7°C but the relative humidity may vary over a wide range from 20-60 percent to control the weight loss of the egg during incubation. The aim is 15 percent weight loss but it varies from 5-25 percent.

Eggs may be set on their side and rolled 90°, or on their end at 45° and turned through 90°, two to six times a day. They are candled weekly to check the progress of the embryo and may also be weighed. Computer programs may be used to record information and predict the final weight loss.

The eggs are transferred to a hatcher on day 39 or 40 and the hatching progress is checked by candling eggs once or twice a day. Most farms assist chicks out of the egg if they are slow to hatch and unhatched eggs are opened to determine and record the stage of death and type of malposition.

On hatching the chicks' navel areas are disinfected with iodine or betadine, and then they are left in the hatcher for 24 hours to dry. The hatch may take up to four days to complete and then the hatcher is cleaned and disinfected with formaldehyde.

During the hatching season the incubator is never empty if eggs are set weekly. Some incubators have trolleys or sliding trays to facilitate cleaning if required. The whole incubator is usually fumigated with formaldehyde weekly, immediately after introduction of the new set of eggs.

BROODING

Very little natural brooding is practised, even of those chicks hatched naturally, because of the risk of the chicks being killed by their parents. Artificial brooding and rearing facilities to three months are often combined.

The brooder shed is usually built with a rough concrete floor and the walls constructed of materials such as brick, aluminium or fibrocement. It is divided into compartments with heating facilities, eaeh taking one batch of chicks. Partitions are made of metal, plastic, fibrocement, brick or concrete panels. A variety of floor coverings are used including 'Astroturf', rubber webbing, flat plastic or rubber mats, or hessian. Loose ingestible materials such as sand, shavings, sawdust and hay are currently used but are being discouraged because of problems with impaction. The heat source is usually an electric, gas or infrared heater adjusted to produce a temperature of 30-32°C at chick level over an area large enough to accommodate all chicks comfortably without crowding.

A set of flat trays containing water and feed are placed around the centrally heated area. An older chick may be placed in the compartment to stimulate the others to eat. Most farmers feed chopped fresh green material (lucerne, cabbage, lettuce, rape, and clover) from the end of the first week and many provide shell grit or bone meal and small stones for the gizzard.

A long outside yard is attached to compartment and chicks are released into the yard as early as possible, even in the first week if it is dry. The yards are usually about 20 m long to enable the chicks to run and strengthen their legs. Green feed may be grown in the yards but all loose objects which the chicks may ingest are removed. Feeders and drinkers from the compartment are usually placed in the yard with the chicks while the compartment is cleaned and dried each day.

GROWING TO ADULT

As there is no established slaughter trade at present[2/], young birds are grown from three months onwards through to breeding age. The facilities used would suit either purpose and are usually identical to breeder facilities but with a higher stocking density (5-7 birds/ha) used for slaughter birds.

In a 60 x 20 m yard there are all weather feed containers and automatic drinkers. Some yards have shelters and most have trees otherwise the birds are as exposed to the elements as in the wild. Shelters may be used to protect the feed from the rain.

The birds may be sexed by visual examination of the cloacal prominences on transfer to the grower yards at three months of age, otherwise sexing is done only on the appearance of mature plumage of the males at one year of age.

NUTRITION AND FEEDING

The following recommendations are based on Tuckwell and Rice (1993).

Age	**Crude protein**	**Consumption kg per bird per day**	**Supplements**
0-3 months	19%	0.4	Lucerne meal or pellets (50g/chick/day) shell grit and stones
3 -24 months	19%	1.5	Lucerne chaff, chopped grass, pasture, grit sources
Breeders - Males and - non laying females	19%	1-1.5	
- Layers	19%	2-3	

[2] 1996

FACILITIES AND HANDLING

Fencing between runs for birds up to three months of age may be up to 1.2 m high. Shade cloth may be put over the fence to provide a visual barrier as well as on the top part of the run. Netting is often put over the runs to prevent attack by birds of prey. Fences may be made of prefabricated panels, ring-lock fencing or plain wire, often with a highly visible white cover on the top wire. All breeder yards have a 0.5 m gap at the bottom for the escape of handlers. Boundary fencing is usually galvanised mesh or netting, buried into the ground and at least 1.5 m high.

Most birds get used to and can be led by one handler. If a bird is not co-operative it is hooded, although not all birds remain calm with a hood and may be easily frightened. Most properties have an ostrich "crush", a V shaped set of smooth padded panels into which two or three people could push a bird to restrain it for examination. Some farms have loading chutes and catching pens which are constructed of wood 2.5 m high.

For safe transportation trucks have a non-slip floor and may be open or covered with canvas. The truck back is usually subdivided into compartments to hold from two to six birds.

For identification many but not all farms use microchips inserted into the pipping muscle at the back of the head of chicks up to one week old, or on the feather line behind the thigh. Other forms of identification include numbered plastic or "Velcro" leg bands placed above the hock, and these have the advantage of providing a visual identification.

SLAUGHTER AND PROCESSING

When regular slaughtering occurs it is expected that birds will be 12-14 months old and weigh 60-100 kg live and have a dressed weight of between 35-40 kg. The trial processing of cull birds involves the feathers being shorn and the birds being electrically stunned and bled out. These procedures will be perfected once commercial slaughtering has been established.

The fillet and 'steak' muscles are separated from the rest of the manufacturing cuts. The processing of the rest of the carcass and the offal has yet to be determined and will depend on the demand for biltong, hamburger mince, pet food and meat meal.

Skinning is acknowledged to be a specialist operation. The value of the skin to the producer is around A$200 while a tanned skin is worth A$400-800. Articles made from the skin may fetch up to A$6 000.

An Australian feather duster company which imports ostrich feathers from South Africa is considering buying Australian ostrich feathers.

DISEASES

Up to three months

With the exception of Newcastle Disease which does not occur in its pathogenic forms in Australia, ostriches in Australia have a similar range of diseases to that of ostriches in other countries.

Apart from embryonic deaths, the highest mortality rate occurs in chicks up to one month of age. The major causes of death to this age are:

- starvation and dehydration due to not commencing eating or drinking;
- impaction of the proventriculus or gizzard due to eating long fibrous materials;
- yolk sac infection;
- infection of the navel from environmental contaminants such as *E.coli*;
- leg defects such as splay legs, bent legs and rickets;
- respiratory disease especially Aspergillosis; and
- hypothermia due to getting wet and/or cold.

A non-contagious condition, "Fading Chick Syndrome", affects the growth of ostrich chicks less than one month old. In 1995 however, a possibly contagious disease causing anorexia leading to rapid weight loss, emaciation and death was found in ostrich chicks two weeks to five months of age, This condition was given the name "Ostrich Fading Syndrome", but no causal agent or treatment has been found (Button 1995). The above diseases are either untreatable or progressive so that treatment is rarely effective.

Over three months

Birds older than three months of age have a low mortality, the main causes of death being trauma from colliding with objects, starvation and bullying. Conditions that are usually untreatable but not fatal are:

- bony defects such as twisted or bent neck or backbone (scoliosis, kyphosis);
- leg defects;
- rolled toes;
- broken or damaged feathers (due to trauma, feather picking by other birds, lice, mites);
- maligned or fractured beak; and
- eye cataracts and blindness due to eye pecking.

Treatable conditions affecting different parts of the body may be:

- conjunctivitis, watering eyes, swelling of facial sinuses (aspergillosis or bacterial infection);
- fungal infection (candidiasis) of the oral cavity, swollen pharyngeal lobes due to bacterial infection which may be associated with septicaemia;
- lowered (S-shaped) or curled neck due to general ill-health or possibly micro-nutrient deficiency;
- lice, skin lacerations and pox lesions;
- prolapse (oviduct in females and phallus in males);
- splayed or spraddled legs which can be taped or hobbled together until the bird can hold them together itself; and

- diarrhoea or red discolouration of the faeces caused by roundworms or tapeworms, coccidiosis, blackhead, salt in water and/or bacterial infections of the gut.

Discoloured urine is not necessarily a sign of disease, although green may be indicative of liver damage, and yellow-orange/red may be due to an excess of vitamin B supplements or carotene.

Birds may be routinely treated for external and internal parasites but no vaccines are used. Blood samples are routinely taken on veterinary examination, and haematology and biochemistry are compared with standard/reference ranges.

Birds are usually sold with a certificate which details their identification and any defects detected by veterinary examination.

ECONOMICS

The following figures were estimated costs and returns given by Tuckwell and Rice in 1993 based on a farm of 20 breeding females producing 200 live chicks per year for slaughter with its own incubator and brooding/growing facilities on a property covering 15 ha.

Expenses:

- Cost of physical facilities A$70 000[3/]
- Cost of feed:
  - 3 months A$525/tonne
  - 24 months A$200/tonne
  - Breeders A$475/tonne
- Total variable costs [4/] A$100 000/year

Income:

- Slaughter birds: A$50 each
- Live birds: A$1 000 each

Note: The above income figures are those estimated for a slaughter industry. In 1994 the income from breeding birds was considerably higher with prices of A$70 000 for adult breeders, A$100 000 for adult breeding pairs and up to A$6 000 for 3-4 month old chicks.

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[3] A$1.33=US$1

[4] including feed, labour, transport and marketing costs but not interest on loans

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This publication provides a comprehensive review of all aspects of ostrich production. Part I provides the reader with the origin and evolution of the ostrich and includes descriptions of the various subspecies found today. The basic anatomy of the ostrich is covered in substantial detail. An overview of the various production systems is given which is followed by detailed chapters covering the practical aspects of management including housing, handling, feeding, breeding, incubation, rearing and disease control. Ostrich products such as meat, skin and feathers are discussed in detail. The final chapter of Part I covers the economics of ostrich production and includes a section on the future of the industry. Part I was written by Dr Magdy Shanawany, a world-renowned ostrich specialist who currently farms ostriches in the United Kingdom and provides a consultancy service. Part II is a series of case studies from a selection of countries that keep ostriches commercially. The case studies include important producers such as South Africa, Namibia and Zimbabwe; newly re-emerging industries such as Australia; and countries where ostrich production is less developed such as Kenya, Ethiopia and the United Arab Emirates. Each case study provides the reader with the current status of ostrich in the country, its development, potential and constraints. Part II was researched and written by Dr John Dingle during a four-month assignment in 1996 as a visiting scientist with the Animal Production and Health Division of FAO. *Ostrich production systems* will provide a standard text on ostrich production for students, researchers and development specialists and will also be invaluable to those already practising ostrich farming as well as those thinking of entering the industry.

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