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THE TANNING AND INDUSTRIAL PRODUCTION OF REPTILE LEATHER UNDER CONDITIONS ENCOUNTERED IN DEVELOPING COUNTRIES 1/

by

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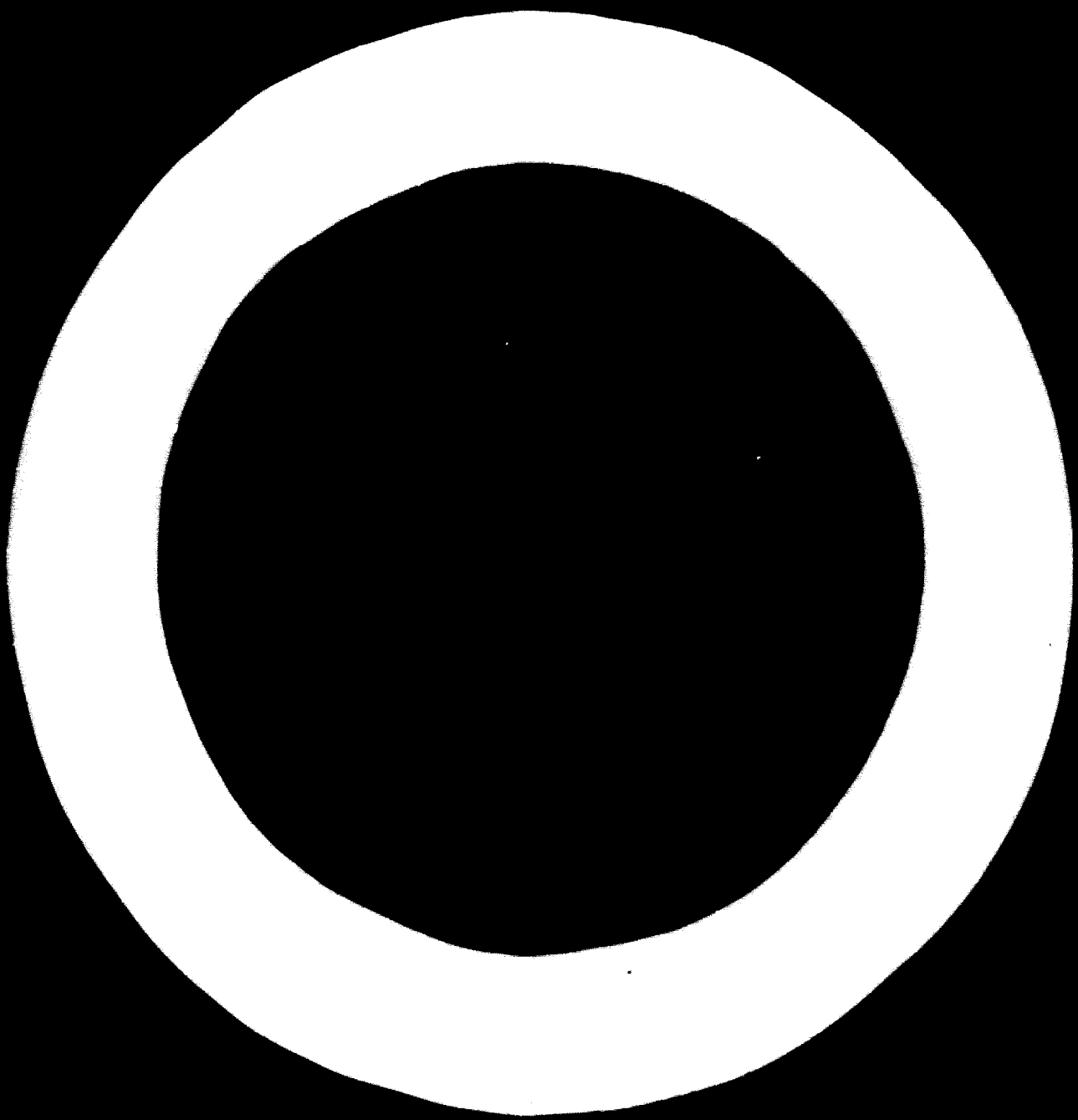

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C O N T E N T S

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INTRODUCTION

The trade in reptile skins has repeatedly come under attack by biologists, herpetologists, institutions and organizations concerned with the preservation of wild life. In an outstanding book on "The World of Reptiles", the authors Bellairs and Carrington denounce hunters of crocodiles as those "who are interested only in the short term profits to be made of the hides, which are used in the manufacture of handbags and other readily saleable articles. The depredations of greedy and irresponsible men of this kind have led to the virtual extinction of the animals in many parts of Africa" (see page 132 of the publication).

The profits made in the reptile skin business are indeed considerable. The skin of an 18 month old estuarine crocodile (crocodilus porosus), 15 inches width, fetches at present US$3 an inch or US$45 a peice, which is almost twice the monthly salary of a rubber tapper in Malaysia. The profitability both individual and national of this trade grows progressively when reptile skins are processed into finished leather and manufactured into shoe and leather goods. It is an important factor in the economy of many developing countries. Reptile leather and its products are the most expensive articles of the leather trade.

But man is not the only, and perhaps not even the worst depredator of reptiles. Lack of parental care during incubation time and post-natal concern for the hatchlings are responsible to a large extent for the rather low reproduction rate of reptiles. Most of the reptiles deposit their eggs on land where they are incubated by the warmth of the soil, without any protection.

Consequently, eggs and hatchlings become easy prey to predatory animals. Even the American alligator which is said to show some sort of maternal concern to his eggs and hatchlings, will soon abandon them and eventually eat as many of the young as he can catch. While indiscriminate killing of reptiles should be certainly prohibited, a modus vivendi must be found to organise the supply of reptile skins to the tanning industry of developing countries, without impairing a reasonable growth rate of this precious livestock. This paper suggests the establishment of farms for breeding and rearing crocodiles for their skins through the supply of eggs or infant animals from natural resources. Herpetologists could co-operate with such farms in solving the problems of incubation and breeding as the reproductive

process of reptiles is affected by conditions under captivity. (See chapter 5 of this paper "Rearing of crocodiles in farms".)

Turning to the production side, in chapter 7, "Reptile skins processing", a general outline of the processes and operations involved in retpile leather production is given, with particular emphasis on methods different from those used in the processing of conventional leather. In the last chapter these principles are exemplified by process formulae for characteristic leather types produced from reptile skins. In these formulae the nature and composition of the large variety of tanning agents and auxiliary chemicals are described, to enable reptile tanners in selecting the appropriate brands and to adjust production processes to their particular conditions.

I. THE POSITION OF REPTILE SKINS PRODUCTION IN THE WORLD'S HIDE AND SKINS INDUSTRY

1.1. Leather - a by-product industry by incidence

The tanning industry owes its existence to the fact that hides and skins have to be removed from the animal bodies in order to obtain access to man's most important food: meat. Stripping off hides and skins, called flaying or skinning, is one of the oldest skills acquired by man. As the stripped-off raw material could not be used as food, and was a highly perishable material, man tried to utilize it for other purposes, succeeding finally in converting it into stable and lasting products: fur and leather. Since those ancient times, fur and leather have become most useful and versatile materials in man's daily life and have remained so throughout his history.

With the growth of meat production, one of the world's largest industries today, the supply of its by-product, hides and skins, has grown adequately, initiating the establishment and steady expansion of the tanning and allied industries throughout the world. Due to the fact that the supply of hides and skins is determined by the demand for meat - not for leather, and there is no other use for this raw material except for being processed into leather, the necessity of close co-operation between hide producing and leather processing industries appears to be logical and highly desirable. Unfortunately, this objective has not been achieved so far. Particularly in developing countries little has been done to obtain the valuable raw material in suitable quality through the application of up-to-date flaying techniques and preservation methods. It happens all too often that developing countries, though abundant in livestock, have to supply their growing tanning industry with imported hides, because of the inferior quality of the local raw material. Modern abattoirs are being built without adequate facilities for obtaining the most valuable by-product, hides and skins, without flaying cuts and other defects. Butchers and abattoir managers are not aware of the importance of a good quality raw hide supply for the prosperity of the leather, footwear and leather goods industries.

1.2 Reptile skins: a main product industry

Contrary to conventional raw hides and skins (cattle and buffalo hides, calf, horse, goat and sheep skins), which are all by-products of meat production, reptiles are hunted, trapped or reared in farms solely for their precious

skins, while their meat is a less important by-product. Perhaps, just because this is the main and not the secondary objective, reptile skins are more carefully skinned and better preserved than the conventional raw material. According to a definition of herpetology, a special branch of zoology dealing with study of reptiles, the term "reptile" (originated from the latin word "repere", meaning: to creep) refers to a group of cold-blooded vertebrates that crawl on their bellies like snakes, or creep on short, stubby legs like lizards, crocodilies and turtles. More specifically: a reptile is a vertebrate animal with scales, it breathes air (not water), and characteristically lays eggs protected by shells and depends on outside sources for its body heat. There are in the world only five main groups of animals that fit this definition. They are the turtles, the lizards, the snakes, the crocodilians, and a strange, little seen creature called the tuatara, which looks like but is not a lizard. There are about 6,000 species of reptiles scattered all over the world. They are most diverse and numerous in warm regions, and are found also on the dusty deserts of the world. There are about 3,000 species of lizards, 2,700 species of snakes, 200 species of turtles, 23 species of crocodiles, and one species of tuatara which can only be found in some islands of New Zealand. Of the five groups of reptiles, only three are leather suppliers: the lizards, the snakes and the crocodilians. One species of turtle, the spineless soft-shelled turtle of the south-western United States is occasionally skinned and its leathery skin processed into glossy novelty leather. With the exception of turtles, a very popular marine dish ("genuine turtle soup") and their eggs, the meat of other reptiles is only used occasionally by the native population. To be mentioned as a curiosity, a publication of Time - Life International "The Reptiles", printed in 1968, contains a formula for the preparation of "Iguana Stew" and for "Japanese Turtle Soup" (on pages 154 and 155). To complete the list, there are also two frog species with very attractive leather skins: the Goliat frog, which lives in Cameroon, and the North American bull frog, also found in the island of Borneo. The hunting and trapping of reptiles for their skins started after the First World War. According to the British Reptile Skin Catalogue of 1933, regular trade at first with India, Indonesia and Europe started in 1926. The same publication exprcssed the opinion that the processing of reptile skins into leather will not depend so much on the whims of fashion, and because of their outstanding properties will become a lasting branch of the tanning industry. In an article of the weekly "Leather" of 29 September 1967, the Managing Director of the well-known

British Reptile Tannery, A T Kinswood and Co , Mr Atkins, describes the excitement caused by the first consignment of reptile skins from Indo-China about forty years ago and how readily they were snapped up by buyers - hungry as always for new types of leather. One of the earliest suppliers were Messrs. De Muinck and Co , in Amsterdam and Messrs. Selig, Sewig and Co , Batavia (today's Djakarta, Indonesia,.

1 3 Some statistics of raw material supply

It is not very difficult to make fairly reasonable estimates of the annual output of conventional hides and skins, as such figures can be derived from data from livestock census and slaughter rates in each country, readily published in leather periodicals and world statistics. In a recent report to UNIDO, by E. Gergely and S. Antonic, on "The role of the hides, skins, tanning and leather manufacturing industries in developing countries" (23 August 1968), the annual supply of raw material was estimated at 1,1 million cattle hides, 9 million buffalo hides - together about the equivalent of 3.6 million tons wet-salted weight; further 400 million sheep and 130 million goat skins, together about the equivalent of 450,000 tons of dry weight. The estimated market value for the total annual supply of hides and skins throughout the world at the present rate amounts to US$1,740 million, an amount which is about twice the value of the world's total natural rubber production at present (see page 3 of the above-mentioned report). Unfortunately, statistics of reptile skin supply are woefully inadequate. In the following paragraphs an attempt is being made to evaluate some supply data from scarce sources which could be made available. In his "Gerbereichemie und Gerbereitechnologie" published in 1967, the well-known leather scientist Professor Stather (Democratic Republic of Germany) estimates recent crocodile skins production at about one million skins annually, collected mainly in North, Central, and South America, further in Africa, India, Indonesia and Madagascar. According to this author:

> "From the point of quality, Indian crocodile skins are of the highest grade, because of their large area of about 15-17 square feet and relatively small scales. While crocodile skins are not suitable for leather because of their bony armour covering completely the whole surface."

Professor Stather's above estimate - without mentioning his source - might be supported by another estimate in Freudenberg's "Häute- und Fellmärkte der Welt", reported in the monthly periodical "Das Leder" (1954, page 89),

which states that the world's largest producer of alligator skins is Brazil with an estimated annual output of 500,000 skins. However, (quote) "due to extensive hunting of these animals their size had been reduced during the years from 7 feet to 5 feet, which means that younger animals had been killed. It is to be feared that in ten years time the alligator stock will be exhausted". Fortunately, this prediction has not come true so far. The fact is, however, that less skins are being shipped to western countries, because the countries of South America have been expanding their own reptile leather tanning industry, by building new, modern tanneries. According to recent private information, a large, modern reptile tannery is under construction in Asuncion, Paraguay, under the assistance of Hoechst Chemical Industries (Federal Republic of Germany) through its leather expert Dr. Karlheinz Fuchs. The tannery is equipped for an annual output of: 1,200,000 lizard skins, 300,000 crocodile skins, 140,000 snake skins and 1,300,000 frog skins. During the last Leather Fair in Paris the exhibition from a large reptile tannery in Madagascar attracted great attention. Europe's largest crocodile leather producing country is France with an estimated output of 300,000 crocodile skins a year, followed by the United States, England and Italy. Reptile tanning in the Federal Republic of Germany has considerably decreased in recent years. Pessimistic predictions of the availability of reptile skin sources in European estimates reflect the diminishing influx of supplies to industrialized countries, since developing countries increasing their processing capacity are reluctant to export their raw material. The Government of India, for instance, imposed a total ban on the export of all kinds of untreated reptile skins, about five years ago. Since then only tanned, semi-finished and finished reptile skins could be exported. The same applies to conventional hides and skins. This ban had a most beneficial effect on the development of India's leather industry. According to a report published in "Leather", in September 1969 on pages 111 - 113, India exported during 1968 - 1969 tanned reptile skins for Rs. 273.58 lakhs (one lakh = 100,000 units) i.e. about US$ 3.65 million (one US$ = 7.5 Rs.). This is an encouraging example for a developing country's successful effort in utilising its natural resources. It should be mentioned that 36 years ago, in 1933, India was one of the world's largest exporters of raw reptile skins, exporting 2.5 million lizard skins to western countries. Indonesia exported at the same time 1.0 million snake skins and 300,000 lizard skins. (See "Mitteilungsblätter" of "Das Leder", 1970, page 5)

The Republic of Singapore is a well-known centre of both reptile skin export and processing. Though its own raw material sources are negligible, this island republic has developed within the last thirty years a flourishing import and re-export trade in reptile skins involving all parts of the world. The export of raw reptile skins has risen from one million US dollar in 1952 to three million US dollar in 1966, according to the external trade statistics of Singapore. The export of untreated crocodile skins amounted to 252,435 lbs valued at M$3,794,745 in 1958, untreated lizard skins 35,268 lbs valued at M$2,969,126, and untreated snake skins 101,669 lbs valued at M$2,164,276 (3 M$ = 1 US$). Singapore has twenty reptile tanneries processing about 10,000 crocodile skins and 100,000 snake and lizard skins annually. The value of exported finished reptile leather amounted to M$1,866,347 in 1968.

The writer feels that some supply estimate should be given, although he is fully aware of the lack of sufficient supporting evidence for such an estimate. The following is based on the assumption that the annual world supply of crocodile skins might be twice that of the recorded production of Brazil, amounting to one million pieces and referring to a size equivalent to 15 inches width - a figure indicated also by Professor Stather. Further, the total annual supply of lizard skins is estimated at 6 million skins, and that of snake skins 3 million, i.e. twice the quantity reported as being exported from India and Indonesia in 1933. Such an approximation may present a basis for discussion to initiate an availability survey of this most precious raw material. In developing countries incentives could be created for the systematic opening up of new raw material sources both by exploring new areas and by the establishment of modern reptile rearing farms. The development of reptile leather technology will also contribute to making accessible new types of reptile skins.

II. HISTOLOGICAL CHARACTERISTICS OF REPTILE SKINS

2.1 The knowledge of the differences between the skin structure of mammals and reptiles is essential to tanners, as this will enable them to apply the proper tanning processes.

2.2 All hides and skins, including reptiles, consist of three main layers: the upper layer or epidermis; below it: the corium or leather forming layer

(in German: Lederhaut), and beneath it: the connective tissue or flesh layer.

The outermost part of the epidermis, a protein substance called keratin, consists of dead cells culminating in hair, horns, hoofs and claws of the mammals, feather of the birds and scales of hairless animals like fish, reptiles and amphibians. In the beginning of leather processing the epidermal layer with all its adherent structure is removed by strong alkalis (liming process), and likewise the flesh layer, in order to obtain access to the leather forming corium.

The leather forming layer, or corium of the mammals (with the exception of pig skin) consists of the upper region: the papillar - or grain layer, characterized by the intrusion of hair shafts and sweat glands; further, of the lower main region, called the reticular layer, which forms the major part of the three-dimensional fibre net-work made up of a protein substance called "collagen" (which means glue forming). The position, dimension and the number of the hair pores determine the characteristic grain pattern of leather. The density and irregular angle of weave of the reticular fibre net-work is responsible for the physical strength of the skin.

Ther American scientist Wilson called the papillar layer the "thermostate" layer, thus indicating its important biological function of keeping the body temperature of mammals constant through the activities of sweat glands and attached muscles. The secretion of sweat produces cold through evaporation, providing the mechanism for protecting the animal against environmental temperature changes. It is therefore not surprising that the hair and glandless reptiles lacking the thermostate layer have to rely on outside sources for their heat supply. Sunshine is essential for the survival of reptiles.

Unlike mammals, in reptiles the flow of collagen fibres in the corium is horizontal, parallel and regular without an interwoven net-work structure. This is the reason why reptile skins are more sensitive towards strong alkalis than the hides of mammals.

The horny epidermal layer of snakes and lizards is periodically shed (thrown off) while with crocodiles this is usually perennial. It follows exactly the pattern of the corium, reaching its maximal thickness on the back of the animals. The main function of the epidermal layer of reptiles

is to protect the animal's body from evaporation. However, the characteristic ossified horny scales and plates are structures of the corium, not of the epidermis. Therefore, after the removal of the epidermis, the characteristic horny structures remain, giving the attractive design of reptile leather. Some sorts of crocodiles also have ossified corium plates on their bellies, which limits their use, though some tanners succeed in softening and removing these plates so that the skins of bellies can also be processed into leather.

2.3 Depending on how the stripping of the skins is carried out, the reptile leather trade distinguishes two types of crocodile skins: "hornbacks" and "bellies". Hornbacks are obtained through stripping of the carcass by incision along the central line of the belly (belly-cut), while "bellies" are obtained by lateral incision on both sides of the carcass, leaving not more than two rows of scutes (scales) on each side (figure 1). Bellies may also be obtained by cutting the skin along the back and trimming off the horny structure (which may be used as buttons on ladies dresses). Hornbacks can be used only if the belly part on both sides of the hunch-back is smooth and does not contain ossified scutes. However, if the bony armour covers the entire skin, so that the scutes overlap each other like tiles on a roof, such hides are unfit for tanning. The best hornbacks are obtained from young animals. They are in great demand by the handbag and leather goods industries. Bellies are used in the shoe industry too. Some sorts of crocodile bellies, i.e. the gavials, have horny plates on their bellies called in commercial language "buttons". In general, buttons and other ossified structures are the result of incrustation of the corium by calcium carbonate and calcium phosphate. Reptiles are protected from the detrimental effect of ultraviolet radiation by the presence of dark melanine-type pigments deposited in the epidermal layer and corium. The removal of the pigmentation in the tanning process is important for the production of plain-coloured reptile leather.

III. NOMENCLATURE AND SOURCES OF COMMERCIAL REPTILE SKINS

3.1 The variety of reptile skins used in the tanning industry is on the increase. As long as reptile leather production was limited to advanced countries, price and quantity considerations were decisive in the selection of raw materials. With the growth of the reptile tanning industry in the countries where the raw material originates, new kinds of skins, even available

only in smaller quantities, could be processed successfully. The establishment of reptile tanneries in developing countries stimulated the discovery of species previously unknown to the reptile leather trade. Recent textbooks on leather technology contain inadequate accounts concerning nomenclature, classification and leather characteristics of reptile skins. As an example we quote a table of reptile skin sources from O'Flaherty's outstanding textbook "Chemistry and Technology of Leather", published in 1962, volume 3, page 453, as follows:

Lizard Source	Types
India	Agras, Calcuttas, Bengals, Ramgodies
Philippines	Half-ring lizards
Indo-China (apparently a mistake by the author, it should be Indonesia)	Java Ring Lizard (Monitor)
Brazil	Lizagators, Chameleons
Columbia	Iguanas
Argentina	Black and white Lizagators
Nigeria	Nigerian Lizards

Snake Skin Sources	
From all over the world	Chouvies, Pythons, Boas, Vipers, Whip snakes, Apalaguos, Anacondas

Crocodiles and Alligators	
From Florida and Louisiana (USA), further imported to the USA from Africa, India, and South America.	

A recently published (1967) German textbook by F. Stather, "Gerbereichemie und Gerbereitechnologie", in the chapter: "Fish - Amphibian - and Reptile Skins" mentions the "beautifully pigmented skins of the Java and Teju lizards (Varanus salvator), further the different types of Python and Chourix snakes as well as Crocodile - and Alligator skins which are processed into luxury leather. Bullfrog skins have a characteristic grain pattern created by their tissue of glands, lizard skins have regularly arranged crest-like hunches, snake skins have strongly pigmented hide scales arranged in characteristic groups. The scales of the snakes are not ossified, as are those of the lizards." (pages 39/40.)

3.2 The most valuable reptile skins are those of the crocodilians (Crocodylidae). The heavily armoured crocodiles, gavials and caimans are the largest of today's reptiles and the last surviving species descendants of the dinosaurs. Full-grown crocodilians range in size from between 3-4 feet in the case of the Congo dwarf crocodile and the dwarf caiman to the top length of 23 feet of the Orinoco (Venezuela) crocodiles. For the purposes of the reptile skin trade, the large number of crocodilians may be divided into four groups: the crocodiles, alligators, caimans and gavials. Though distinctly different from the herpetological point of view, in the reptile skin trade both crocodiles and alligators mean the same. While in Europe the commercial term for the whole group is crocodile, in the United States the name of alligator is more common. The snout of the alligator is shorter and blunter than that of the crocodile, while unlike the alligator, the crocodile's fourth lower jaw tooth stretching over the upper-lip is visible when its mouth is closed. The caiman is related to the alligator but its snout is slender. The South American caiman is the fiercest biter of the crocodilians. It is also the noisiest, letting out thunderous roars during the mating season or when wounded. The gavials have the narrowest snouts of any crocodilians. The Indian gavial is a timid animal which usually retreats at the sight of man. The African crocodiles are notorious man-eaters.

3.2.1. Depending on whether the back or the belly side of the skin is used, commercial classification distinguishes between hornbacks and bellies. Their commercial value depends on the size of the scales. Consequently there are small-scaled and large-scaled bellies and hornbacks. Small-scaled ones fetch the highest price, followed by large-scaled bellies and hornbacks. The reason for such differentiation lies in the fact that bellies can be used for both shoe-uppers and leather goods, while hornbacks can only be used for leather goods. Among large-scaled bellies there are again two types: the more expensive ones without "buttons", and the cheaper ones with "buttons".

3.2.2 Some of the finest small-scaled bellies are those from the Sampit crocodile, named after a town in Indonesian Borneo. Another well-known collecting and shipping place for bellies and other reptile skins in Borneo is Bandjermasin. The species is Crocodilus porosus, in English "Estuarine crocodile". It lives mostly in brackish rivers

but in the area of the Sunda Islands it goes out far into the sea. The crocodile of inner Thailand is the similar Crocodilus Siamesis. Small-scaled bellies are also obtained from the so-called Peak Crocodile, the term is a translation from the German "Spitzkrokodil" (C. acutus). It is a native of Mexico and Columbia, with the trade name Largatos Panzas. The Orinoco crocodile from Venezuela (C. intermedius) has also small-scaled bellies.

3.2.3 Medium scale bellies are obtained from the Mississippi Alligator (A. mississippiensis), called in German "Hechtalligator" (in translation: "Pike Alligator"), from its resemblance to the fierce freshwater pike fish. It is a native of the southern United States. The Louisiana bellies are famous from being most carefully skinned and properly preserved. They have button-free bellies. Other medium-scaled bellies are obtained from the crocodile acutus, a species found in Cuba, called Havanna or Cuban Crocodile, and further from the Javanese so-called Estuarine Crocodile (C. porosus). Hornbacks are also obtained from this species. This species is also found in the brackish waters of Fiji, India, Northern Australia, South East Asia, and the Sunda Islands. It is caught in large quantities particularly in Australian New Guinea.

3.2.4 Hornbacks and large-scaled bellies are obtained from the so-called Australian Crocodile (C. johnsoni), processed only in Australian reptile tanneries. The Madagascar Crocodile (C. robustus) is a particularly heavily armoured species, but is still processed into hornbacks in the tanneries of this island. The Madagascar Crocodile has much in common with two African species: the East African Nile Crocodile and the West African Armoured Crocodile (C. niloticus and C. cataphractus). The West African species are considered as unsuitable for tanning because of their thick skin and bony belly structure. However, it seems that the younger skins are still successfully processed in the countries of origin, mostly as hornbacks. The East African Nile Crocodile is one of the best known crocodile species in the skins trade. The dwarf crocodile of the African Congo is used as small hornbacks in the tanneries of Singapore. The Swamp Crocodile (in German Sumpfkrokodil, C. palustris) is a native of Burma, Ceylon and East India(Assam States), very similar to the Nile Crocodile, but with less ossified large-scale bellies and hornbacks.

3.2.5 Several sorts of caiman skins have become increasingly popular. Among these are the large-scaled bellies of the Black Caiman (in Germar "Mohrenkaiman") of Central South America (Melanosuchus niger), further the bellies and hornbacks of the Spectacle Caiman (in German Brillenkaiman, Caiman crocodilus) found in the north, central and southern parts of South America, as well as the large-scaled bellies of the Wide-Snout Caiman (Caiman latirostris).

3.2.6 There are two types of gavial skins used in reptile tanning: the Ganges Gavial (Gavialis gangeticus) of North and East India, and the Sunda Gavial of Indonesia (Tomistoma schlegelii) both with heavy back armour and buttoned bellies.

3.2.7 In general, crocodiles living in salt water have small-scaled, büttonfree bellies but heavily armoured backs. Those living in sweet waters, i.e. in rivers or artificial ponds, usually yield large-scaled bellies and hornbacks. From those living in a combination of salt and sweet waters, i.e. in the mouths of rivers entering the sea, a variety of scale sizes may be obtained.

3.2.8 Summing up this chapter we may note the remarks of a well-known reptile skin tanner, the late F. Wolff-Malm of Germany as follows: "While the Indian Crocodile shows the most uniform scale size, the North American (Louisiana) alligators, though of varying scale size, are those with the best flayed and the best preserved skins. The raw material from Alabama, Georgia, and Louisiana is preferred to the skins from Florida and Mexico. Considerably far behind comes the quality of skins from Central and South America, like those from Ecuador, Guyana, and Panama." (Handbuch der Gerbereichemie und Lederfabrikation, third volume, second part, page 342.)

3.3 While the general appearance of the crocodilians is rather similar, with little difference among the four groups, the crocodiles, alligators, caimans and gavials, the lizards (Lacertidae) are suppliers of the most diverse types of leather. They can be found on every continent except in the polar regions. They vary in size from the 3 - 4 inches long Geckos up to the 10 feet long Komodo "Dragon" weighing 100 lbs. The Geckos are resident in all tropical

countries as family or household pets, loved by many people as very useful insect eaters. They live in houses, on the walls behind pictures and mirrors, in cupboards and drawers. A somewhat larger species is the likewise popular Tokay Gecko, which lives under house roofs and on neighbouring trees. The names Gecko and Tokay, in Malay called "Chick-Chack" are suggestive of the sounds they emit. The giant Komodo is a native of the small Indonesian island of Komodo where it is officially protected. The Komodo is a ferocious and indiscriminate carnivore, which occasionally attacks even smaller deers and pigs. None of the above-mentioned reptiles are leather suppliers. Most lizards readily shed their tails when in danger. The broken-off part jumps, evidently to divert the attacker's attention so that the animal may escape. A new tail usually grows again. Some lizards are connected with horrifying myths and fantasy, like the "Thorn-devil" Moloch Horridus, named after the ancient Babylonian god to whom children were sacrificed. "But despite its fearsome name, this Australian lizard is only eight inches long, and subsists on a diet of ants, consuming from 1,000 to 1,500 at a single meal" (from "The Reptiles", Life Nature Library, page 27). There are lizards with small tails resembling frogs, called Frog Lizards, further, legless snake-like lizards, and ones which resemble crocodiles, although smaller in size. Some of these reptiles prefer rivers as their hunting ground, like the so-called Crocodile Teju, while those with umbrella-shaped bodies may cover large distances in gliding flight. Some types are masters in changing their colour, for which the Chameleons are proverbial. This change of colour is due to pigment deposits in the epidermal cells, which react under the influence of light and temperature by changing the pigment concentration through contraction and expansion of the cells. This also occurs as a result of excitement of the animals during fighting or when engaged in courtship.

The author of "Leather suppliers of lower vertebrates" (Informative letters of "Das Leder", 1960, issue 1, page 1) divides lizards into four groups: the Agamids (Agamidae), the Iguanids (Iguanidae), the Tejus (Tupinambis) and the Monitors (Varanidae). The name "Monitor" implies that these large, flesh-eating lizards "warn" of the presence of crocodiles. The above sequence of four groups reflects the increasing tanning value of the skins.

It is rather difficult to distinguish the Agamids from the Iguanids, as they have a number of common characteristics. These are ridges and crests

extending often to the tails, culminating upwards in long, pointed, irregularly arranged scales, giving the animals a frilled, toothed profile. While the Agamids belong to the Old World, mainly to Asian and African countries, the Iguanids can be found only in the New World, in the Americas.

3.3.1 The Agamids, called also Hydrosauriae, as their Latin name indicates, are aquatic lizards, living in rivers and forests. One of their more important skin suppliers is the Asiatic Gliding Lizard. The Gliding Lizard is a native of the South Indonesian archipelago around the island of Ceram and named after the seaport Amboina: Hydrosaurus Amboniensis. Its gliding mechanism is decorative and multi-coloured, with a back crest widening on the tail part to umbrella-like wings, that may have a steering function. It is also an excellent swimmer.

Other Agamids belong to the Uromastyx family and are inhabitants of the dry regions and deserts within an area spreading from North Africa to Central India. They have thorny tails used for digging holes in the soil which may also deliver heavy blows to attackers. There is also the Uromastyx Aegypticus, the Uromastyx Acanthinurus from North Africa and the Uromastyx Hardwickei from Pakistan and India. The average width of their skins ranges from 15 cm to 110 cm.

3.3.2 The best known type of the Iguanids is the Green Iguana, called Common Iguan or South American Chameleon (Iguana iguana) which lives in the tropical forests of Central and Northern South America. It grows to 2 metresin length. The Green Iguana is an arboreal reptile which can be recognised by crescent-shaped scales on the neck and back side and by the uniform pearl-like scales on the belly. It is a specialist in the art of camouflage. On the impact of light or a rise in temperature or in state of excitement it may change its colour from grey to brown, green or even yellow. Skinning is carried out along the ridge line. The pigmentation of the corium is not pronounced, as the green colour belongs to the epidermis, which will be removed during the tanning process.

Similar species are the East African three-horned Jackson's Chameleon and the Black Iguana of Mexico and Panama.

3.3.3 The third group, the Teju Lizards (Tupinambis) are also inhabitants of the New World. With a few exceptions they are also arboreal reptiles. Teju skins have a pronounced black-white grain pattern on the finished leather. The Crocodile or Armoured Teju (Dracaena guianensis) is found in Guyana. It grows to a length of 1.5 metresand is skinned by cutting on the belly side, therefore, the skins is also called Hornback Teju. It is a water reptile living in the tidal forests of the Amazon, which feeds on snails and lays its eggs in abandoned termite nests.

The large Yellowband Teju (Tupinambis nicropunctatus) is found in Brasil and Columbia. Its popular name is "Egg Thief" or "Poulterers Wolf" because of its special liking for poultry eggs. It is also called the Great Teju as it is often over one metre in length and the skin is 40 - 60 cm wide. The Teju Proper (Teju tejuixin), also called the Brazilian Lizard, extends its habitat as far as Argentina. It has the most decoratively pigmented skin among the lizards, with pigments deposited deeply into the corium. As the pattern of the back differs from that on the belly, by cuts through the ridge line or belly, different grain markings can be obtained on the finished leather.

3.3.4 The fourth group and certainly the most important skin suppliers among lizards are the Monitors or Varans (Varanidae). The Varans have a dragon-like shape consisting of a long neck followed by a massive trunk and a long, thick tail. The body is carried by strong legs ending in frightening claws. Like snakes, they have a narrow forked tongue which can be lashed out from the mouth. Unlike other lizards, the Varans are unable to shed their tails or regenerate them if cut off. They prefer muddy waters where they swim and dive like crocodiles, but may also visit forests. Their food consists of fish, crabs, frogs, birds, rats and occasionally also chicken. Due to their strong structure, the Varans have less enemies than the other lizards. Their greatest enemy, however, is man, not only because of the delicacy of their meat, but mostly because of frequent chicken thefts. All Varans are skinned along the central line of the belly. Some species have ossified corium plates, but they are rather soft and do not impair the leather quality. In Indonesia and Malaysia commercial language distinguishes between "Ringed" and "Unringed" lizards as a distinction between a pronounced black and

white ring pattern and a blurred or hazy appearance of the grain. One type of unringed lizard found in Malaysia is called the Gabus Lizard. The price of the ringed skin is about twice as high than that of the unringed. The most important Varan is the Sling Varan (in German "Bindenwaran', Varanus Salvator), called also Javanese Varan or in Malay speaking countries Biawak. The African Varan or Nile Varan (Varanus niloticus) is very similar. Both have a black and white grain pattern more pronounced in the "ringed" and less in the "unringed" types. Their skins are cut along the central line of the belly. The East Indian and Chinese species are called Ramgodies. While both species escape into rivers in case of danger, another Indonesian lizard, the Tree Lizard (Varanus rudicollis) finds shelter in trees. Other common types are: the Fish Lizard of Indonesia (Varanus dumerilii), the Desert Varan of Algeria and Pakistan (Varanus grisius), the Prairie Varan (Varanus exanthematicus), found in the grasslands of West Africa and in the area north of the Equator, the South African Cape Varan (Varanus albigularis), and the Yellow Lizard in North India (Varanus flavescens). The Bengal Lizard (Varanus bengalensis) and the Agra Lizard or Oval Grain Lizard are found in India. Their skins are used in large quantities in Indian tanneries. Most of the Varans, with the exception of the Varanus Salvator lose their contrastful design on reaching maturity. All are skinned along the central belly line. The minimal width acceptable for skins for tanning is 20 cm measured on the widest part of the trunk. Skins over this width fetch progressively higher prices.

3.3.5 Wolff-Malm divides the most widely used lizard skins by geographical classification into the following four groups (Handbuch der Gerbereichemie und Lederfabrikation, volume 3, part 2, page 349/50):

(a) The <u>Java Lizard</u> (Varanus Salvator) from Indonesia, is the most beautifully pigmented reptile skin, with contrastful black rings on a snow-white background;

(b) The <u>Indian Lizards</u> according to their origin are divided into Agra, Bengal and Calcutta Lizards. Though similar in size and shape, they differ in scale formation. Their natural markings are not characteristic enough, therefore, they are bleached in the tanning process and finished as plain-coloured shoe upper leather. Less

numerous are the Hornback Lizard and the Thorntail Lizard (Uromastix Hardwickei) preferably used in the handbag industry;

(c) The South American Lizards. Because of its natural marking the Teju Lizard (Tupinambis tejuixin) found both in Brazil and in Argentina in large quantities, plays an important role. Less important and cheaper are the Jaqurarus and Chameleon skins;

(d) The African Lizards consisting of Iguanas, Varans and Chameleons participate both in quantity and quality much less than the other three groups."

3.4 Snake skins have particular advantage over other reptile skins due to their uniformity of width throughout their length, tape-like form and lack of extremities such as legs, crests, hunches and scutes, which make possible the application of machine techniques like shaving, splitting, paste and vacuum drying. Wolff-Halm gives the following (rather indistinct) account of the leather supplying snakes (Handbuch der Gerbereichemie und Lederfabrikation, volume 3, part 2, page 344) as follows:

Name	Type	Origin	Length
Python Snakes:	Pythoniae:		
Tiger Snake	Python Molurus	India	3 - 4 metres
Diamond Snake	Python Javanicus	Indochina - Java	6 - 8 "
Rock or Hieroglyph Snake	Python Sebaae	Africa	4 - 5 "
Water Snake (Karung)	Acrochordus Javanicus	Indonesia	1 - 2 "
Boa (Ciboya) Snake	Boa Constrictor	Indochina - South America	6 - 10 "
Anaconda (Sucurry) Snake	Eunectes Murinus	South America	6 - 7 "
Coral Snake	Ilsya Scitale	Indonesia	60-70 cm
Die Snake	Tropidonotus Tesselatus	Iran	up to 1 metre

Herpetologists classify the more important snakes in four families: (see "The Reptiles", Life Nature Library, page 14), the Boideae, Colubridae (both non-poisonous), the Viperidae and Elapidae (poisonous).

(a) The Boidae consist of the New World's boas and anacondas and the Old World's tropical pythons. They are the best known snakes. According to well-authenticated records boa constrictors grow to 18 feet length, pythons 33 feet and anacondas over 37 feet. Pythons and boas resemble each other closely, but the former lay eggs and the latter bear live young, as do the anacondas. Pythons dare to swim out far away from the shore. After the destruction of the island of Krakatoa in 1883 by volcanic eruption all living creatures were destroyed. The first reptiles arriving by sea in the neighbouring islands of Java and Sumatra were python snakes.

(b) The Colubridae is by far the most diversified snake family. It contains about two-thirds of the world's snakes. The water snake, the whip snake, ribbon snake, chicken snake, black snake, scarlet snake, green snake, hognose snake, horn snake, king snake and many others belonging to this family. Because they are found almost everywhere, they are called "typical snakes". Most of them lay eggs but some bear their young alive. Some eat any living prey they can catch and swallow, some are specialized, i.e. the hognose snake prefers toads, the red-bellied horn snake eats mostly salamanders and the king snake eats other snakes.

(c) The Viperidae, consisting of the family of vipers, are poisonous snakes, found in all continents except Australia. There are two well-marked groups: the true vipers, confined to the Old World, and the pit vipers, found mainly in the New World but some related species are also found in Asian regions. The wedge-shaped or heart-shaped head is generally thought to be the mark of a poisonous snake. The name pit snake refers to a sensory depression, or pit, between the eye and nostril, an organ that helps in detecting warm objects. Pit vipers include rattle-snakes, the South American bushmaster, the Central American eyelash viper and others.

(d) The cobras and other members of the family Elapidae are inhabitants of the world's tropical regions. They are generally slender as compared with vipers but all deadly poisonous. Like vipers they kill prey by venom injected through fixed hollow or grooved fangs situated towards the front of the upper jaw. They differ in temper. Some are timid burrowers in leaf mould like most of the American coral snakes, or the likewise poisonous sea snakes which stay in the sea and give birth to their young

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alive Their venom, though adapted to kill fish, is also virulently poisonous to warm-blooded animals. However, there seem to be no records of a sea snake attacking swimmers or divers. Although several other species are most deadly, the cobra has the worst reputation of any venomous snake. This is partly because of its large size and fearsome appearance, but mainly because it comes in constant contact with the inhabitants in crowded Asiatic countries, taking the lives of a large number of people. The fearsome face of a cobra is actually no face at all but a set of black and white markings on the back of its neck which it spreads defensively when disturbed. The venom of a newly born baby cobra right out of the egg is as deadly as that of its parents! The venom of the rattlesnake is as deadly as that of the cobra, but the former strikes and delivers its venom faster because of its poison fang being located further forward.

This herpetological classification will certainly not satisfy the reptile tanners, but the writer feels it is necessary to know their characteristics and habits. From the point of view of leather technology, a classification based on pronounced and contrastful, respectively dull or flat, corium markings appearing after the removal of epidermis, would be more appropriate. To mention the two extremes: the unique, brilliant corium pigmentation of a Diamond Python and the indistinct, blurred or hazy grain pattern of the Karung and the Whip Snake, which suggest the processing of leather in "natural" black and white patterns from the former, and plain-coloured leather from the latter type.

3.4.1 Snake skins with characteristical distinct grain patterns are the following:

The Tiger Python or Python Molurus, found in Indonesia, Malaysia, and in North India, with a distinct but rather bright corium pattern of oval, chain-like, longitudinal markings in a horizontal direction, along the middle line of the skin, from 6 to 20 feet in length and 18 to 35 cm wide.

The skins of the Diamond Python (from German the translation: Network Snake) or Python Reticulatus of South East Asia including the Philippines, is the most costly snake skin in the reptile leather trade.

Its markings are unique, very pronounced, consisting of a chain of almost hexagonal, diamond-shaped, symmetrical geometrical figures along the central line of the skin. Length and width are similar to the Python Molurus.

The Rock Snake or Hieroglyph Snake (Python Sebae) of Africa, 2 - 8 metres long, and 16 - 62 cm wide, with stretched out oval figures embedded in a channel-like, longitudinal pattern along the central line.

The Giboya Snake or Boa Constrictor, a native of South America, 1.50 to 5 metres long and 16 to 55 cm wide, with very characteristic elongated egg-shaped markings, set in a line along the centre of the back.

The Anaconda Snake of Brazil, Guyrana, Paraguay and Trinidad, (Eunectes Murinus), is the largest snake known, growing up to 12.50 metres in length and 85 cm in width, with alternating, asymmetrical dark circles above and below a horizontal line along the central part of the skin.

The Cobra Snake or Spectacle Snake (Naja Naja) of South and South-East Asia, with triple or single spectacle-like markings on its underside immediately below the head, in the so-called "hood". The skin is 1 - 1.80 metres long and 10 to 17 cm wide.

Similar to the Cobra Snake are the Rattle Snake, the Bread Snake (Crotalus Durissus Terrificus), the Coral Snake, the Hoomoood Snake, the King Snake, of the New World, the Black Cobra of Africa, and the King Cobra of India, Ceylon and the Indo-Australian islands.

3.4.2 Snake skins with indistinct or hazy grain patterns:

The Javanese Water Snake or simply Karung (Acrochordus Javanicus) lives in the brackish waters of Indonesia and in the region between Malaysia and New Guinea. It swims out far in the sea and breeds on the islands. Karung skins are used in large quantities by reptile tanneries all over the world. Their length is about 2 metres and their width does not exceed 30 cm. The skins are covered with small nipple-like protrusions which have to be softened in the tanning process, otherwise the surface of the finished leather becomes coarse and rough.

The skin of the Whip Snake, a native of India and South-East Asia, is very popular in reptile leather tanning. Large quantities of so-called Madras Whips are exported to Europe in tanned, semi-finished state for

further finishing. It is a water snake, therefore, called also Ayer Snake (in Malay Ayer means water). Its Latin name is Ptias Mucosus. A relative of the Ayer Snake is the Churie Snake. Both have thin leather substance but very smooth grain surface. Therefore, they are suitable for processing into plain-coloured smooth leather and also for finishing with transfer foils to gold and silver leather.

The African Mambas, among them the highly poisonous Black Mamba (Dendroaspis Polylepsis or Naja Nigrocolis) grow to a length of 4.5 metres. They live in Africa and South Asia.

The Bushmaster Snake (Lachesis Muta) found in the region from Panama to Brazil, and also in Bolivia and Paraguay, grows to 3.7 metres. The belly side of the skin has characteristic scales. Other snake skins used frequently (to mention a few more species) are those of the Indian Chain Viper (Vipera Russellii) also found in Burma, and Siam, and the Rhinoceros Viper (Bitis Arietans) found from the southern part of the Sahara right down to the Cape.

3.5 Although they do not belong to the family of reptiles but to the Amphibiae, the very decorative skins of several frog species are used in considerable quantities in reptile leather tanneries. Only the larger species are suitable, such as the skin of the Goliath Frog (Rana Goliath), the Bull Frog (Rana Catbesbyana), and the Sprinkled Frog (Pyxicephalus Adspersus) which is found in Africa (Cameroon), Indonesia (Borneo), and in eastern and northern parts of the USA. Frog skins are very suitable for tanning since they are not covered either with scales or horny structures. As a substitute for hair or scales, frog skins have strongly developed glands which sometimes produce poisonous or at least smelly secretory substances. There are larger and smaller glands spread over the entire skins surface, and as they are all structures of the corium, they give the leather made from frog skins a very decorative pattern. Larger skins have an average width of 20 cm which limits their use to small novelty leather goods.

IV. REARING CROCODILES IN FARMS

4.1 The reason for the indiscriminate killing of crocodiles lies in the high price obtained for their skins. A properly flayed and preserved small-scaled crocodile belly is sold for US$4 per inch of width in the Singapore market at present, i.e. US$60 for a skin 15 inches wide. This is equivalent to two months salary for a rubber tapper in Malaysia. The price of a large-scaled skin is US$3 per inch of width, and that of a hornback US$2.50. It is not surprising, therefore, that hunters have been rushing to crocodile-rich jungle places, carrying out mass slaughter of the animals. Because the supply of salt for preservation and transport facilities were often inadequate, thousands of valuable skins have been wasted.

4.2 In some African countries the hunting of crocodiles is limited or even prohibited in order to preserve wild life. But man is not the greatest enemy of crocodiles. Birds, snakes, lizards and other predators destroy most of the eggs, so that the rate of reproduction is very low. For the same reason, even in protected preservations, only about one per cent of the crocodile eggs produces hatchlings. If eggs and hatchlings could also be protected there would be plenty of room both for the increase of livestock and the provision of prospective crocodile farmers with eggs or infant animals for the production of the precious skins. This would also create additional employment and earnings.

4.3 The writer has been in touch for several years with a very experienced crocodile farmer in Malaysia. Mr. Wong Loong Fatt, who has his farm on the island of Penang. He has been raising the species Crocodilus Porosus for the last fifteen years from infant crocodiles supplied from tidal rivers in Malaysia and Thailand. It took about fifteen months to raise four-week old crocodiles to the standard size of 15 inches in width. Infant crocodiles are fed with shrimps and small fish. When they grow larger they are fed with meat wastes, and later with the meat of flayed crocodiles. The cost of food for this period amounted to M$15 for one animal. He never succeeded in obtaining eggs from his crocodiles, as the conditions in captivity were apparently not conducive to mating. Now he is unable to obtain any young animals, at any price. Crocodiles in Malaysia's tidal rivers have become rare because of the reckless killing of the mature animals for their skins with no regard for

eggs and hatchlings. The writer was told by Mr. Wong that in other countries, like Thailand, crocodile farmers are successful in obtaining fertile eggs and hatching them both under natural conditions and also in incubators. Farming of crocodiles for their skins is the only way of meeting the shortage of this valuable raw material. Mr. Wong suggests the establishment of modern water ponds in which sea and sweet water can be mixed, and adequate mating, nesting and hatching conditions provided. Hatchlings should be separated from the mature animals immediately after they emerge from the eggs; the best species should be selected for breeding and a certain quantity of standard size - by ensuring an adequate growth rate - disposed of, properly flayed and the skins preserved for delivery to reptile leather tanneries. However, the creation of modern farming conditions under scientific control requires the support of government institutions. The success of crocodile farming in developing countries will, therefore, greatly depend on the interest of the governments in supporting this undoubtedly lucrative trade.

4.4 In his book "The Reptiles" (Time - Life International, printed 1968), the biologist Dr. Archie Carr gives a detailed account of the mating and breeding habits of reptiles. The writer wishes to quote some of his findings as they might be helpful to the problem of crocodile farming. Reptiles are the group that introduced internal fertilization to the vertebrate line. The reptilian egg enters the world already fertilized, and protected to a certain extent against adverse conditions. But even an egg with a shell is delicate. It can incubate successfully only within a narrow range of conditions of temperature, humidity and shelter. While many lizards and snakes are reptiles which bear live young, crocodilians produce only eggs. The courtship of the crocodilians is noisy. "When the female approaches", says Dr. A. Carr "the two of them race about in wild circles, making a big wake that rocks the roads and sends the fishes flying. The frogs stop singing and the waterfowl scream". Crocodiles lay their eggs in sand, soil, humus or rotting logs. Care for the eggs during incubation, or for their young after hatching is not characteristical, with the exception of the alligator. "The female American alligator", writes Dr. A. Carr "builds her nest by biting off huge mouthfuls of damp vegetation and combining them with mud to form a mound which may be six feet wide at its base and a yard high. From 15 to 80 eggs are then laid in a hole scooped out of the top. This is promptly covered by material pulled from the rim and packed down smooth. Unlike most reptiles,

which abandon their eggs after laying, the alligator hovers about to guard the eggs from other animals. When it is time to hatch, the baby alligators make faint squeaking sounds, signalling their mother to amble over and help them to tear open the mound. The parental care of the female alligator lasts about two months, then it may disappear completely, and she will eat as many of her offspring as she can catch!".

V. FLAYING AND PRESERVATION OF REPTILE SKINS

In a publication of the Food and Agriculture Organization of the United Nations (FAO) on "Rural Tanning Techniques", Development Paper 68, printed in 1966, detailed instructions are given on the flaying and preservation of reptile skins.

5.1 Reptile skins, such as crocodile, alligator, lizard, snake and frog skins make very attractive and durable leather. Unfortunately, owing to faulty preparation, reptile skins often reach the tanners in too bad a condition to tan. The usual blemishes which by a little care could be easily avoided, are cuts, gouge marks, bad shape, scale slip and putrefaction. Damage due to delayed flaying or dragging over rough ground is also common. So is damage due to overdrying or overexposure to the sun, to distortion and overextension, or to the action of beetles after the skins have been dried. If first-class material is to be obtained, the correct methods must be used to catch, collect and flay the reptiles, and preserve their precious skins. Reptile skins are the highest paid raw material for tanning. Tanners pay for a properly preserved crocodile skin 15 inches in width as much as for ten pieces of light cattle hide weighing about 12 kilograms a piece. For the price of one cattle hide weighing 12 kilograms (about US$5.50) one may purchase about three pieces of Java Lizard skin 10 - 13 inches wide, or about two python skins 2.50 metres in length, or ten Karung (water snake) skins about 1 metre in length, or ten frog skins. These are present primary producers' prices in Malaysia. This comparison shows that it pays well to handle reptile skins with the utmost care.

5.2 The catching and killing of reptiles must be done by humane methods, as in case of meat producing animals. Spearing and battering reptiles to death with hammers, sticks and stones will certainly not secure a perfect skin. Larger reptiles, like crocodiles, large snakes and large lizards are shot in

the head with one bullet, as done for instance by experienced hunters in New Guinea. Smaller reptiles are brought into the skin dealers' shops alive. We have had good experience with anaesthetic methods by using chloroform. Formaldehyde injection is unsuitable because of its tanning effect, which prevents the removal of the epidermis in the tanning process. We experimented with the electrocution of reptiles in pig slaughterhouses but this proved inefficient.

5.3 The flaying of reptile skins is to be done immediately, before decomposition can take place, at least within three hours after the death of the animal.

5.3.1 Lizard, snake and frogs are opened down the belly, from the tip of the chin to the end of the tail in a carefully drawn straight stripping line. Stripping should be carried out not on the ground but by hoisting the carcass, as is done with other carcasses in the abattoirs. Some of the Iguanas and Chameleons are opened along the back and their legs are cut along the centre line. After the skin has been taken off, fleshing and scraping off the loose tissues and removing the blood by washing and scrubbing must start immediately. It is most important to obtain the full spread and proper shape, otherwise the skin cannot be flattened in the tanning and drying processes, consequently in shoe and leather goods manufacturing the cutting surface of the leather will be reduced due to trimming wastes.

5.3.2 Crocodiles, after being shot in the head between the eyes, should be removed from the water immediately. A longer stay in the water may cause irreparable damage to the precious skins through putrefaction. The carcass should be dragged out from the water upside down, so that the back and not the belly comes into contact with the ground. No time should be wasted between flaying, fleshing and salting. From the moment the carcass has been brought into the dealer's shop until the skin is salted, speed is essential. Delay in preservation may cause slip of the epidermis and the corium below it will become "sueded". This commercial expression refers to slight damage to the delicate belly side consisting of slight putrefaction of the grain, which is hardly visible in the raw state, but it appears on the tanned leather as a suede-like surface that makes it

unsuitable for glossy finishing. The skin should never be exposed to sunlight. Dry skins interfere with tanning. When flaying, the skin should be pulled away from the body with one hand, for the knife is used only to cut through the flesh layer. This eliminates damage by cuts and scores. If the armour covers the entire back, only the belly can be used. Only two rows of scutes should be left on each side. This is important because crocodile skins are sold by the width, measured across the widest part of the belly. Figure 1 shows a properly flayed crocodile belly; figure 2 the proper ripping lines; figure 3 the measured width of the belly. As soon as the skin has been separated from the carcass, it should be placed on a completely flat surface. Any surplus meat, fat or tissue should be scraped or cut off. After fleshing the skin should be thoroughly washed - or, preferably, scrubbed with a brush - while water from above is poured over it.

5.4 Preservation of reptile skins:

5.4.1 Lizard, snake, and frog skins are preserved by drying in the shade in a stretched state. The skin, flesh side up, is nailed to a wooden board with 2 - 3 cm long aluminium nails, projecting above the skin. Then the skin is raised from the board up to the head of each nail. This makes a clear space of about one cm under the skin, and it allows the air to circulate beneath. Drying by spreading the skin on the ground will cause putrefaction of the side that touches the ground because of lack of air circulation. Care must be taken that direct sun does not scorch the skin. On all occasions, therefore, drying should be done in the shade. Although most snake and lizard skins are preserved by air-drying, excellent results have been obtained by wet-salting. As a matter of fact, tanners always prefer wet-salted skins because of the ease by which rewetting and processing itself can be carried out. Only fine salt should be used, for coarse salt needs a longer time to penetrate. After the meat has been scraped from the skin, salt is rubbed evenly into the flesh side. The addition of one per cent sodium-penta-chloro-phenate to the salt increases its antiseptic power. The skins are kept flat, so that the brine can drain off easily. The skins can be air-dried after the salt is shaken off. They are then said to be "dry salted". If, however, wet-salted skins should be produced, a second salting is necessary in the same way. The skins are

now rolled, flesh side inwards, from tail to head, so that a neat bundle is formed. About twelve skins may make up one bundle. Throughout the salting, it is essential to keep the stock in a wet condition by covering it with wet bagging. Dry goods in bales must be protected against beetles. Sprinkling with naphtalene or with one of the modern insecticides like gammexane powder assures full protection.

5.4.2 Crocodile skins must be preserved by wet-salting. Air-dried crocodile skins, due to their horny structure, are difficult to rewet and, therefore, unsuitable for tanning. Fine salt containing as additional preservative one per cent sodium-penta-chloro-phenate is rubbed into the flesh side of the skin. After a few days the skins are drained by hanging over a wire with the flesh side uppermost, until dripping ceases (figure 4). After two hours of draining a second salt coat is applied. For transportation the preserved crocodile skins should be rolled, scales inward, and there should be a layer of antiseptic salt between each skin. It has been often said that the production of leather starts with flaying and preservation, and the leather we are using for so many purposes is not better than the raw skin leather is made of. If only those dealing with the preparation of raw skins could be made aware how much the tanning industry depends on their care, there would be more and better leather at less cost.

VI. REPTILE SKIN PROCESSING

This is a rather neglected field of leather technology. There are only very few references in textbooks as to the know-how of reptile tanning, therefore, technicians or industrialists intending to take up reptile tanning have to resort to trial and error to find the right technology. Reptile tanneries all over the world keep their processes as a tightly guarded "secret", refusing entry or visits to their tanneries from outsiders. Tanners in developing countries lacking know-how but abundant in reptile skins are very often unable to produce quality leather from the valuable raw material.

6.1 For instance, O'Flaherty's "Chemistry and Technology of Leather", volume 3, page 451, printed in 1962, contains only a vague, one-page reference under the heading "Reptiles", while for all other sorts of leather detailed process and

equipment descriptions are given. The reader of this textbook may get the impression that the processes involved in reptile tanning are more or less the same as those for conventional leather, which is not correct. "The skins from crocodiles" the author says "must be handled with extreme care, because the enamel of the grain surface is very thin and can easily be worn away with rough treatments in paddles or drums. Actually, still tanning with gentle manual movements will bring best results". The author omits the answer, i.e. how to tan one hundred crocodile skins a day by "gentle manual movements". In fact, even small reptile tanneries employ paddles and drums, specially constructed for this purpose, without damaging the grain of the skins. The allusion to "usual tanning techniques" often encountered misleads and disappoints the student in his quest for information from well-known textbooks. Another textbook, in German, Grassmann's "Handbuch der Gerbereichemie and Lederfabrikation, Die Lederarten und deren Herstellung", (Publisher: Springer, Vienna, 1955, with 183 photos, 79 tables, on 1268 pages, price: US $85.20), which is the largest publication on practical tanning processes of all kinds of hides and skins, contains more information on reptile tanning but in a very generalized form. Apparently, in an effort to supply their consumers with information on the use of their tanning chemicals, some German chemical factories have recently been publishing pamphlets on reptile production which contain some helpful hints. The Badische Anilin & Soda-Fabrik AG., Ludwigshafen, issued in 1964 three booklets, as follows: "Suggestions for the Tannage, Dyeing, and Finishing of Crocodile and Lizard Skins"; "Suggestions for White Tannage for Snake and Lizard Skins"; "Directions for the Manufacture of Shark Skin and Reptile Leather". From the Bayer Chemical Industries: "The Production of Reptile Leather" in 1965. Further from the Hoechst Chemical Industries: "Oxidative De-scaling and Bleaching of Reptile Skins" in 1965. The weakness of these pamphlets, however, is that the processes refer to European conditions of temperature and humidity, while in tropical countries with a yearly average water temperature of about 25 - 28°C chemical reactions proceed much faster, therefore the processes applied have to be adjusted accordingly. This applies also to the relatively high humidity in tropical tanneries, amounting to 65 per cent and above.

6.2 Unit processes and unit operations involved in the production of reptile leather.

This chapter refers to chemical and physical changes of reptile skins in sequence as they occur in production from the raw material to the storage of finished leather. At the end some characteristic process formulae for different types of products will be given.

6.2.1 Soaking

The raw material, as it enters the first processing phase, soaking is either air-dried, as in the case of snake, lizard and frog skins, or wet-salted as for crocodile skins. Each processing lot should contain the same type of skins, preserved in the same way and of the same size. It is inadvisable to mix different species in the same lot as this may interfere with the processing methods. Wet-salted skins should never be mixed with dry ones. During the whole process each lot should be processed and recorded separately for calculation purposes, therefore the number of skins pertaining to the same lot should be adapted to the optimal capacity of the equipment, mainly to the v[illegible] of pits, paddles and drums. Dry skins should be carefully inspected and those with blood stains kept separately, as they may fall apart in the processing because of putrefaction. Regardless whether preserved by drying or by salting, the lot has to be weighed and recorded according to its weight on entry.

6.2.2 Dry skins have to be soaked or rehydrated (re-wetted) until they regain the weight and softness they had after being removed from the carcass. As the original raw skin weight is unknown, it can be established in an indirect way, namely, by continued soaking until a constant wet weight has been obtained. This is about 300 per cent of the dry weight. In order to acc[illegible]te the soaking process, both antiseptic penetrating agents and [illegible]nical movement must be applied. There is a large number of antisep[illegible]soaking (penetrating) agents, such as Mollescal C of BASF, further Cismollan BH of Bayer, or Diamoll F and C of Hoechst. The amount to be used is 1 g per litre liquor. The quantity of liquor is

20 - 30 times the dry weight of the skins. Other products like common salt, sodium hydroxide and sodium sulphide also accelerate rehydration. Soaking in a slowly rotating drum at about 3 revolutions per minute provides the necessary mechanical movement. In the case of overdried skins, dry drumming after one day's soaking may be helpful. Under tropical conditions normally air-dried lizard and snake skins require about 24 hours soaking time. After complete soaking the skins must be soft, and slightly plumped. Then the soaked raw material is weighed (so-called soak weight). Wet-salted stock, mainly crocodile skins, are soaked for not more than 12 hours by changing the float twice and using the above-mentioned wetting agents supported by the mechanical action of drums or paddles with a 400 - 600 per cent float. The soak weight of wet-salted stock is about 120 - 140 per cent. After soaking, the skins are fleshed over the beam by hand and flesher's knife - if necessary. They should enter liming with as little flesh layer as possible.

7.2.3 Liming

The objective of liming is the removal of the epidermal layer and the flesh layer (connective tissue) in order to liberate the true hide layer (Corium), to remove also the soluble, interfibrillar proteins and to provide for a certain degree of plumpness to facilitate the absoprtion of tanning agents in subsequent processes. This can be achieved either by keratin dissolving alkalis such as sodium sulphide, sulphydrate and hydrated lime or by the Hoechst Oxidative method using chlordioxide (Imprapell CO). From the two alkalis, sulphide and lime hydrate, the former dissolves keratin easily but the latter strongly attacks on the collagen fibres of corium and the natural pigments embedded in this layer as well. Therefore if natural pigmentation of the skins is to be preserved, it is inadvisable to use lime, or on the contrary, in case of blurred and hazy natural markings which have to be removed, the use of lime is essential. Due to the lack of a three-dimensional fibre network in the corium, as pointed out in chapter 2.2, reptile skins in general are less resistant to strong alkalis than conventional mammals' skins. Therefore the reptile tanner must be most cautious in determining the amount of liming alkalis. The sensitivity or reptile skins towards sodium sulphide

increases in sequence with crocodile, lizard, snake and frog skins. In the writer's experience the concentration of sodium sulphide in liming frog skins should not exceed 0.5°Be, that of snake skins 1°Be and lizard skins 1.5°Be. (1°Be solution contains 14 g. sodium sulphide in flakes, 60/62% per litre.) If natural black and white pigmentation is to be retained, 24 hours sodium sulphide liming with occasional drumming is sufficient. If the maintenance of natural marking is not required, one day after liming with lime hydrate is necessary. The sodium sulphide should be free of iron, since iron may cause discoloration of the skin. Liming is completed if scales and the epidermal layer can be easily removed by brushing the skin with water at 35°C. The liming of crocodile skins is carried out with a mixture of sodium sulphide and lime until the scales are removed and, due to the thickness of the skin, reliming in pure lime hydrate solution is advisable. The total liming time is about three days. In all cases the limed skins have to be most carefully checked for complete removal of epidermal scales, as these cannot be removed later. Scales prevent tanned leather from uniform dyeing.

6.2.4 Fleshing

Snake and crocodile skins have much stronger developed flesh layers than lizard and frog skins. This layer can be removed by hand using 50 cm. long spring fleshers over wooden beams. The adherence of the flesh and fat layer would interfere with tanning if not completely removed. Highly skilled workers in the reptil tanneries of Singapore are able to reduce the thickness of the skins to 1 mm. and during this fleshing operation also to cut out the horny corium plates (buttons) from the reticular layer of the bellies. Such horny plates weigh sometimes as much as 2 kg. Fleshing and thinning operations take about 2 hours for one crocodile skin, depending on thickness. This would be a too expensive labour-consuming operation in industrialized countries, therefore a strong hydrochloric acid pickle is used, which softens the horny plates by dissolving the deposits of calcium carbonate and calcium phosphate. Then, after the subsequent tanning process, the skins are shaved with special reptile shaving machines.

6.2.5 Deliming and Bating

The limed, descaled and fleshed skins must be delimed to make them prepared for tanning. As a rule, the acidity of the deliming bath must not be below pH 4, otherwise the fibre structure of the skin may be damaged due to acid swelling. If liming was carried out only with sodium sulphide without limehydrate, water alone will provide sufficient deliming without the addition of acid. Otherwise, weak acids, acid salts or aromatic acidic compounds are used for deliming. The Badische Anilin & Soda Fabrik, Ludwigshafen, produces under the trade name Decaltal a non-swelling acidic salt of an aromatic acid, which is a safe deliming agent. Its non-swelling character is due to its composition as a rudimentary tanning agent which attaches itself firmly to the hide substance so that no acid swelling can occur, despite its strong acid character and low pH (1.6 - 1.8 in 10 per cent solution). Reducing acids, like sodium bisulphite or coloured acids, like lactic acid, can not be used if white leather or leather with the natural black and white markings has to be produced. In continuation of the deliming process the skins are treated with Proteolytic Enzymes that provide slight peptization of the collagen fibres accelerating the take up of the tanning materials in the subseqent tanning process. A number of such products are available, among them one, Cropon ZR2 of the Rohm & Haas Company, is particularly designed for preserving the natural markings of reptile skins. It is also advisable to add in the deliming - bating bath sulphonated castor oil or emulsifying agents, such as the recen. Baymol A of the Bayer Company, to obtain smooth, clean grain. The optimal pH of bating is 8 and at the end the cut of the skin must be alkali free. The optimal temperature of the deliming-bating bath is 37°C. Bating must be done very carefully since over-bating will weaken the hide structure. Usually one hour is sufficient. Bating is completed if the skins are completely smooth and soft.

6.2.6 Bleaching

Reptile skins for plain coloured leather have to be bleached to remove pigmentation and to produce a white pelt. Bleaching of reptile skins has become increasingly important today due to the fact that naturally pigmented leather is out of fashion and the shoe and leathergoods industries require plain coloured reptile skins. This poses quite a delicate problem particularly for heavily pigmented lizard, python and boa skins. There are three methods of bleaching reptile skins, mostly applied in the delimed and bated state:
(1) oxydation with hydrogen peroxide; (2) a two-bath process with potassium permanganate and sodium bisulphite; and (3) a process developed by the Hoechst Chemical Industries with chlorine dioxide (Imprapel CO). In the following paragraph the permangate bisulphite method is described and an outline of the reactions involved is given.

Potassium permanganate is a powerful oxidant which readily oxidizes organic substances, thus also pigments deposited in the corium of the skins. In these reactions heptavalent manganese is reduced either to the tetravalent state, in which case the product is the dark brown insoluble manganese dioxide, or to the bivalent state, forming almost colourless soluble manganese salt. The nature of oxidation reaction depends on the medium in which it is carried out. In acid solution, heptavalent manganese is reduced to bivalent manganese, while in neutral or alkaline solution it is reduced to tetravalent manganese, or manganese dioxide. We may denote the formula of the pigment with C, indicating the element carbon as its main characteristic component, and assuming that in the oxidation process it will be oxidized to carbon dioxide CO_2, the above-mentioned two alternative cases may be formulated as follows:
(a) $4\ KMnO_4 + 5\ C + 6\ H_2SO_4 = 2\ K_2SO_4 + 4\ MnSO_4 + 6\ H_2O + 5\ CO_2$.
In the second case of oxidation in neutral or alkaline solution:
(b) $4\ KMnO_4 + 3\ C + 2\ H_2O = 4\ MnO_2$ (precipitate) $+ 4KOH + 3\ CO_2$.
In case (a) the presence of sulphuric acid exerts a much higher oxidation power, since four molecules of permanganate oxidize five pigment units, while in case (b) the oxidation power is lower, oxidizing only three pigment units. Due to the fact, however, that no only pigments but also

the hide substance itself is an organic matter, the permanganate reaction may destroy the skin as well if the oxidation power is too high. Therefore it is advisable to adjust the oxidation level accordingly. Strong skins with dense pigmentation (e.g. python skins) may be bleached in slightly acidified solutions, while thin skins should be bleached in alkaline or neutral solutions. As a further precaution oxidation should take place in a 10°Be solution of sodium sulphate, as sodium sulphate acts against peptization. The use of sodium chloride instead is not advisable since chloride ions have a peptization effect. Usually 8 - 12 g potassium permanganate per one litre 10°Be sodium sulphate solution (10 per cent) with the addition of up to 0.1 per cent concentrated sulphuric acid - calculated on pelt weight - will be sufficient for the removal of even strong pigmentation. This refers to all reptile skins including crocodile skins. After the oxidation bath the skins should have a dark brown colour due to the absorbed manganese dioxide, and the pigmentation should be completely covered so that no markings are visible. Then the skins are squeezed to press out the water and lowered into a fresh 10°Be solution of sodium sulphate brought to pH 3 by the addition of Decaltal. Now the second treatment: removal of the precipitated manganese dioxide from the skin by sodium bisulphite follows according to the following equation:

$$MnO_2 + NaHSO_3 = MnSO_4 + NaOH.$$

Thus, the tetravalent dark brown manganese is reduced to the colourless bivalent state and the skins become white, the natural markings having completely disappeared. Here again is a pitfall which must be avoided. Namely, as the equation shows, sodium hydroxide is formed as the result of the reduction of the manganese dioxide that raises the pH of the solution. It is essential to prevent the solution from raising its pH, otherwise the skins will be destroyed. Therefore the acid condition of pH 3 - 3.5 must be maintained during the reduction, which is completed within one hour. The skins may remain in the bisulphite bath over night. After some experience the student will easily find out whether the skins are sufficiently acidic: slipery skins indicate pH over 4, which has to be put down to the above 3 - 3.5 immediately by adding more Decaltal. Rough skin surface indicates sufficient acid in the solution. The reason for decomposition of the skins above pH 4 may lie in the

absorbtion of oxygen during the interaction between colloidal manganese dioxide and bisulphite, stimulated by the presence of sodium hydroxide, which therefore has to be neutralized through the addition of Decaltal. The nature of this process still requires further research. The amount of bisulphite required for the reduction of the manganese dioxide is about four times the amount of permanganate used in the first bath. In the first (oxidation) bath 300 per cent float (calculated on pelt weight) should be used, in the second (reduction) bath 300 per cent, to avoid a temperature increase above 35°C. The bleaching of crocodile skins requires particular attention as the delicate grain layer may become "sueded", i.e. showing rough grain due to slight decomposition of the papillar layer. Therefore, bleaching must be carried out at a low oxidation level, i.e. in neutral or alkaline permanganate solution, just to oxidize the pigment, not to attack the grain. The bisulphite bath has to be kept on an acidity level not over pH 3, sufficient to neutralize the sodium hydroxide formed in the reaction, which otherwise could decompose the skin. Snake and crocodile skins have the tendency to tangle during drumming, which causes unevenness of the reactions involved in other processes such as bleaching, tanning and dyeing. Therefore, it is advisable to sew the skins in twos, side by side, with a few stitches, and keep them so until all the drumming processes are completed. Then the skins can be separated again for drying and finishing.

As far as the other two bleaching methods are concerned, the writer's experience with hydrogen peroxide was unsatisfactory. The Hoechst oxidative descaling and bleaching method with Imprapol CO produces leather with a good tensile strength. It combines both the removal of the epidermis and the bleaching in one process that takes 24 hours. However, complete bleaching requires additional permanganate-bisulphite treatment. This method is also applicable to syntan-vegetable tanned leather for detanning and bleaching of the natural markings. After detanning the skins can be retanned by any tanning process. (For details see: S. Goethel: "Oxidative descaling and bleaching of reptile skins", available from Hoechst Chemical Industries, Frankfurt).

6.2.7 Tannage - fatliquoring - dyein·

Reptile skin processing is usually carried out in two stages: at first, the skins are tanned, fatliquored and dried to be converted into fully tanned but unfinished so-called "crust" stock; in the second stage crust leather is re-wetted, re-tanned, dyed and finished to the final commercial product. The reasons for two-stage process are both technological and commercial. In the "crust" the conversion of raw skin into leather is completed. It is a fully tanned, non-perishable raw material from which proper selection regarding colours and designs required by customers can be made. After re-wetting, dyeing and finishing, the unique structure and grain pattern of the reptile skin is fully preserved. Processing of the delimed and bleached pelt may be divided into tanning for white leather and tanning for coloured leather. From the technological point of view this means tanning with light-fast white syntans, respectively combined chrome-syntan-vegetable tannage.

(a) White tannage.

To obtain white leather with contrastful natural markings, or plain white leather that will not turn to yellow while being glazed, synthetic tanning agents which are specific condensation products of phenol with tanning capacities equivalent to natural vegetable tanning materials, are used. Such "replacement syntans" are superior to natural tan extracts regarding their fastness to light, white tanning effect and prevention of mould growth on leather. Tannage with aluminium salts, still used in some tanneries, is inferior to syntan tannage as aluminium oxide does not combine irreversibly with the hide substance and does not produce truly tanned, stable leather. Zirconium salts produced by chemical industries in Europe and the U.S.A. are now widely used for tanning white leather; however, there is not sufficient evidence regarding their applicability to reptile skins.

There is a number of well-known syntan brands used for white tanning, such as Tanigan Supra 3LR of Bayer, Basyntan DLX or BASF, Irgatan LV of Geigy, and others. Pickled skins after depickling to pH5 are tanned in containers or in rotating tanning drums (12 r.p.m) in increasing concentrations of syntans, starting with 0.5° Be up to 4°Be for 3 to 5 days. Repickling to pH5 is necessary

in order to avoid acid swelling which might occur in the first weak syntan bath. The end - pH of the tanning liquor is about 3.5. Tanning is completed when a specimen of leather dries out soft. The tanned skins are piled up overnight, then shaved, returned to the syntan bath for one day, rinsed, fatliquored and dried. Shaving is carried out on a normal 300 mm shaving machine with a small 100 mm feed roller. Any shaving machine can be adjusted for this purpose. Fatliquoring is carried out either in long floats with 300 per cent water at a temperature of 45°C with emulsions of light-fast sulphated oils and raw oil, or in a float-less fat bath. The addition of some titanium dioxide or white pigment, on oxalic acid and syntan to the exhausted fat bath help to improve the white content and fixation of the fatliquor. The fatliquored leather is dried in freely circulating air not exceeding 40°C by hanging, which takes about one day, and then put on store as crust leather. More efficient, time and labour saving is drying under vacuum. The wet leather is set out on the steel plate of the vacuum unit with grain side down and then dried at 60°C for 2 - 4 minutes, depending on the thickness of the skins. It is essential that the skins are laid out completely flat before vacuum drying, otherwise they become creased.

Crust leather is now sorted out for dyeing. Faultless skins are used for white or pale shades, the others for darker colours. The skins are then rewetted in warm water with the assistance of a wetting agen , then returned into the same syntan bath, re-fatliquored, dyed with anionic dyes or in combination with basic dyestuffs and either nailed on to boards with copper nails for drying or dried under vacuum. Finally, they are buffed on the flesh side by an overshot rotating buffing wheel coated with No. 50 silicon-carbride powder.

(b) Combined Tannage

While crocodile skins with button-free bellies may proceed after completed bleaching directly for tanning, buttoned bellies require special pickling with strong acid concentration to soften the corium plates by dissolving the deposits of calcium carbonate and phosphate. The skins are intermittently drummed in 15°Be

sodium sulphate solution with 10 per cent hydrochloric acid, which may be increased to 30 per cent within three days depending on the extent of the horny plate formation. The amount of hydrochloric acid used is calculated on pelt weight. When the skins are sufficiently softened they have to be depickled with sodium thiosulphate and sodium bicarbonate in a 10°Be salt solution to a pH slightly higher than that of the tanning solution. This is about pH 3 - 3.5 for chrome pretanning, respectively 4.5 - 5.5 for pretanning with syntan-vegetable mixture. The skins are now ready for tanning.

Combined tannage consists of the application of basic chromium sulphate salt in one bath and a mixture of syntan and vegetable tans in the subsequent bath. If tannage starts with chrome followed by syntan-vegetable tanning the leather is called "chrome-retanned". If it is done in the opposite way: at first with syntan-vegetable tans followed by chrome, one speaks of "semi-chrome" tannage. In the final effect both tannages may result in similar leather qualities. Chrome-retanned leather is usually somewhat firmer, semi-chrome leather softer. Chrome tanning alone without retannage is seldom used as the crust of such tannage is very difficult to rewet properly. As a matter of fact, the semi-chrome process has its origin in the so called Indian Tannage. For decades large quantities of vegetable tanned hides and skins, among them also reptile skins, have been exported from India to European and American tanneries for retannage by chrome and finishing to a large variety of shoe uppers, garment and luxury leathers. East Indian (usually called E.I.) leather has become a most important item in world leather trade.

There are several brands of basic chromium sulphate salts used in tanning. They are standardized products in powder form and should be easily soluble in cold water. Their chromium oxide content (Cr_2O_3) is adjusted to 25 per cent while their basicity ranges from 33 per cent to 66 per cent. One of the standard products is BAYER's Chromosal B, chrome I of 66 per cent basicity. The writer has been using a self-prepared basic chromium sulphate liquor for many years. Its characteristic feature is: alkali-

resistance, which means - unlike all other chromium sulphate salts - it does not precipitate with alkalis even in neutral or alkaline reaction. The advantage of this liquor is that it can be adjusted with soda ash to any required basicity without the danger of precipitation of chromium hydroxide which causes green chrome-spots on leather. Crocodile skins should be tanned with 2.5 per cent Cr_2O_3 - calculated on pelt weight and should stand the so called boiling test. This is necessary as tanned crocodile leather undergoes special heat treatment in finishing in order to obtain the much desired protruded or moulded grain form called also "bombé" effect. Other reptile skins are tanned with less chromium oxide (1.5 - 2 per cent) and do not necessarily have to stand the boiling test. A shrinkage of 10 per cent when boiling in water is allowed. During chrome tannage basicity can be increased either by the addition of sodium bicarbonate and sodium sulphite or a BASF buffer salt called Neutrigan. Basifying with alkali can be avoided by starting with the 33 per cent basic chromosal B and completing tanning with the 66 per cent basic Baychrome A that brings pH to 3.8 automatically. Floatless chrome-tanning produces fuller leather and better exhaustion of the chrome liquor. The chrome tanned skins are shaved on the reptile shaving machine to an even thickness. The softened buttons of chrome tanned crocodile skins can be easily removed by shaving. After neutralization of the skins with weak alkalis (calcium formate, polyphosphates, sodium bicarbonate and alkaline buffer salts) fatliquoring and retannage with syntan-vegetable tan mixture follows. Chrome tanning with less chrome requires heavier, with more chrome lighter retannage. Syntans of the light-fast types or others and mimosa extract are mostly used in retanning mixtures. The amount varies from 15 per cent to 30 per cent with about one third of the mixture consisting of syntans. The tanned skins are rinsed, fatliquored and dried by hanging or under vacuum and the product thus obtained is crust leather. Crust leather must be soft if the process is carried out properly. After sorting the crust stock is rewetted, retanned with syntan, fatliquored, dyed with anionic or in combination with basic dyestuffs, nailed

on boards for drying or dried in vacuum. Vacuum drying requires the additional use of cationic fats (e.g. Lipamin liquor O of BASF, or Eucoricil WSP of Stockhausen) and formic acid to provide for fixation of the anionic fatliquor. The dried leather is buffed again on the fleshside and is now ready for finishing.

Tanning in the opposite way (semi-chrome) starts with auxiliary or replacement syntans, followed by mimosa extract, about 10 per cent each. Tanigan CH of Bayer, Basyntan J Powder of BASF or the above mentioned light-fast white tanning syntans may be used. After complete and thorough tanning the skins are shaved, washed and then retanned with 5 - 10 per cent Chromosal B. During tanning the chrome liquor is basified with sodium bicarbonate and sodium sulphite up to 3.8 to 4 pH of the liquor. Basifying with alkali may cause green chrome spots from precipitated chromium hydroxide. To avoid this, half of the amount of chrome should be made up of the 33 per cent basic Chromosal B and the other half by the 66 per cent Basichrome A. The higher basicity of the latter and its magnesium carbonate content exerts a self-basifying effect which makes the addition of alkali unnecessary. The optimal pH of 3.8 is reached automatically. Basifying with sodium sulphite or Neutrigen instead of sodium bicarbonate likewise prevents the formation of chrome spots, due to the former's alkali resistant effect on chromium solution (called "masking"). The skins retanned with chrome may not necessarily stand the boiling test. Shrinkage allowance of about 10 per cent can be tolerated. Floatless retannage produces softer leather and better exhaustion of the chrome liquor. The tanned skins are shaved, neutralized, fatliquored and dried for crust. After sorting for corresponding colours the stock is rewetted, slightly retanned with syntan and mimosa, fat-liquored, dyed and dried either nailed on boards or in vacuum.

Vacuum drying requires adjustment of the fat liquor by additional use of formic acid and cationic fatliquor (e.g. Lipamin Liquor O of BASF or Eucoricil WSP of Stockhausen) in order to provide for fixation of the anionic fatliquor and to prevent migration of the fats into the felt sheet on the top of the

vacuum drier.

The dried leather is buffed on the flesh side and is then ready for finishing.

6.2.8 Finishing.

The term finishing refers to a number of operations aimed to render the surface of dyed and dried leather scuff-resistant, water-repellent, soil-proof, pleasing to the eye and to give it good compatibility with renovating polishes. In our technological age, which turns out new "man-made" synthetics alternative to "products of nature", the customer has become more sophisticated and he wants to know the nature of material which is used in the production of the goods he intends to buy. Due to the competition of materials alternative to leather, recently a new dimension has appeared in classical finishing techniques, emphasizing genuine grain patterns by which one sort of skin may be distinguished from another. Thus, one of the new objectives of finishing is the identification of the various skin species in finished leather. Unfortunately, finishing techniques appearing after the second world war have completely neglected this aspect by making the finished leather as uniform as possible to increase its cutting value in the manufacturing industries. Consequently, the use of heavily pigmented plastic finishes have made leather plastic-like. Customers could not distinguish genuine leather from plastic materials and have been buying the cheaper, plastic ones. The present trend in leather finishing therefore does not try to hide the leather's natural features, but to emphasize them, even at the cost of uniformity. After all, the products of nature are never uniform in their surface appearance, neither wood, nor gems nor pearls, why should leather be?

Following this trend, the tanning industry is producing now from selected raw materials so called "aniline leather", leather with "aniline finishing". This term implies the use of water soluble aniline (synthetic) dyes in finishing solutions contrary to plastic finishing based on insoluble opaque pigments. High quality reptile leather that emphasizes the specific, distinct grain pattern of reptile skins is an example of aniline leather. The finishing solution padded or sprayed on to the leather surface contains as colouring matter special homogenous

anoinic dyes, or depending on the evenness of tanning, fatliquoring and dyeing, a small amount of highly disperse, transparent aniline pigments which are almost water soluble. The finest sorts of reptile leather are only drum-dyed and the finishing solution does not contain any colouring matter, only substances which make the leather surface smooth and resistant, as mentioned above.

The dried leather as it is removed from the board or from the vacuum drier is buffed on the flesh side, as mentioned in the previous chapter, then trimmed. It is essential that the leather is flat and straightened out, otherwise the finishing will be uneven. This is quite a problem in the case of small and very soft lizard skins. If the skins are not flat they should be conditioned and nailed on boards anddried, whereby the creases are smoothed out. The finishing solutions, called also dressings or seasonings may be divided into glazing, plating and polishing finishes, reflecting the mechanical operations by which the final appearance of leather is obtained. A glazing machine consists of a glass, agate or highly polished chrome-silver steel cylinder, which moves backwards and forwards on the leather surface on the bed of the machine. The bed of the machine is covered by a 4 mm thick flexible leather belt with a slightly rounded edges. The width of the belt depends on the size of the skins and on the smallest area which has to be glazed. For small lizard skins, for instance, a one cm wide belt is used, for bigger skins the belt is up to 4 cm wide. The belts should be easily interchangeable, as larger areas of the same skins have to be glazed by a wider belt, whereas narrow areas need the smaller belt. The pressure can be regulated by springs and by a foot pedal.

For plating finishes a hydraulic press with heating elements, adjustable pressure and a timing device is used. A hydraulic press with a platen dimension of 1370 x 660 mm has a maximal pressure of oil in the circuit of 255 atm and total piston power of 500 tons. At maximum pressure of the oil circuit the pressure per one square cm surface is 55 kg. In smooth plating usually 100 atm. oil pressure is used equal to about 22 kg/sq. cm. Polishing of the finished leather surface is carried out by a rotating wooden wheel covered with cotton-plush. Various combinations between the three basic finishing techniques are also possible.

(a) Finishing solutions for glazed leather may be coloured or colourless. White tanned reptile skins are padded and sprayed with a solution of proteins and non-thermoplastic polyamide containing binders, then fixed with formaldehyde solution, dried and glazed. In case of plain-white leather without natural markings a small amount of white pigment may be added.

Coloured skins may obtain a cationic ground solution consisting of cationic casein (e.g. Eukanol Ground A of Bayer or Cationic Ground of Earnshaw Co. Ltd., England) that seals off the anionic leather surface. After drying, a top seasoning of anionic protein binder may follow, and after fixing with formaldehyde solution and drying the leather can be glazed. Unevenly coloured leather or black leather is padded with the above mentioned cationic base coat that also contains basic dyes. It is essential that the base-coat dye should match with the shade of the drum-dyed leather, otherwise discoloration of the glazed leather occurs. The cationic coloured base-coat is followed by an anionic polyamide or protein solution but without dye. After drying and fixing the leather is glazed.

Another alternative is to use an anionic base coat with protein binder and brillant dyes, then to spray with the same but colourless solution, fix, dry and glaze.

For stronger colour correction of the drum-dyed leather surface a base coat containing protein dispersed anilin pigments (e.g. Tanil colours of the Hoechst Co.,) with non-thermoplastic binders may be applied to leather by padding and spraying, then a colourless season sprayed on, dried, fixed and glazed.

Base coats if coloured contain 4 - 5 litre of dye or 20 g/litre of anilin pigments. There is a large number of protein materials and polyamide non-thermoplastic binders available. Among the former are cow milk, casein, egg-white (egg albumen), gelatine, linseed mucilage; among the latters are Luron Binder, Luron Top, [illegible] Lustre of BASF, [illegible] Lustre of Bayer, [illegible] and [illegible] Wax Top of Hoechst, [illegible] Finish of [illegible] and others. For a dark brown anionic base coat the addition

of preserved ox blood, and for a black anionic base coat the addition of ox blood and haematine (dyewood extract) improve glazing properties and gloss. Twitching of the leather surface while glazing, particularly of soft leather, due to heat and friction between leather surface and roller, may be overcome by slight wiping of the leather surface, belt and glazing roller with a plush cloth impregnated with linseed oil.

The glazed leather (except hornbacks) is finally plated on a hydraulic press with about 20 - 25 kilograms per square cm.pressure at 60° - 80°C for 5 seconds. Hornbacks are only glazed on the smooth surface, while horny areas remain dull. Plating stabilizes smoothness and gloss.

Crocodile bellies are shaved in the dry state on a special dry-shaving machine, then finished, glazed, plated as usual, and as the final treatment, they are exposed in an oven with open door to a temperature of 150° - 180°C for 5 - 10 minutes to obtain the moulded effect with protruded scales ("Bombe - effect"). (German patent of Andreas Braun, DBP 901 696, approved on 14.1.1954).

(b) The term "plated finish" applies to the use of an aqueous solution of pigments and thermoplastic polyacrilates or acrylic-butadiene copolymers as binders. Such a finish is not glaseable because under the pressure of the glazing roller the finish becomes plastic, soft and sticky. After padding and spraying of the finish the leather is hot-plated. Now a top seasoning of nitrocellulose emulsion of polyurethane lacquer dissolved in organic solvent is sprayed to make the surface water-repellent and glossy. The last operation is again plating at 65°C and 25 kilogram/sq. cm pressure.

Another type of plating finish uses metallized transfer foils, which are available in endless sheets 67 - 120 cm. width, in gold, silver, black and a range of colours. To get a good lamination between foil and leather and a continuous film, a coat of a suitable acrylic binder (Corial

ground ON of BASF or Plastodeim FD of Hoechst) is applied to the leather surface. After plating the laminated foil at 80°C and 25 kilogram/sq. cm. pressure for 10 seconds, the covering paper or plastic sheet is peeled off and the leather surface appears in its metallized pattern. Snake skins with smooth surface like Chip skins, Chourie, Ayer and small Python skins are particularly suitable for gold, silver and black patent plating. Karung skins prior to foil treatment have to be flattened on the hydraulic press with 40 kilogram/sq. cm. pressure at 80° to get the small protrusions of the grain smoothed out.

(c) A polishing finish is used on reptile skins if a dull, silky gloss appearance is required. This is a technique applied for garment and glove leather. The skins are padded and sprayed with a transparent pigment solution containing thermoplastic binders. After drying they are sprayed with a top seasing of wax emulsions and fixing agents, dried and polished on the plus wheel. Neither glazing nor plating are required. Large python skins for fashionable reptile garment leather may be finished in this way.

(d) In chapter 7 an outline of the basic principles of processing of reptile skins, from soaking to finishing, have been given. In the appendix of this paper several practical processing formulae will exemplify the above principles.

VII. PROCESS CONTROL

Even the smallest reptile tannery can afford simple facilities to control production. These are as follows:

(a) 1% alcoholic solution of phenophtalein indicator kept in a dropping bottle; it turns red at pH 8.3, below, it is colourless.

(b) 0.1% solution of bromocresol green in 50% alcohol kept in a dropping bottle; yellow colour indicates pH3, bright-green pH4, blue-green pH5 and blue pH6.

(c) Universal indicator paper ranging from 1-12 pH (Lyphan, Pehanon or other brands).

(d) Universal indicator liquid ranging from 1 - 12 pH.

(e) A few thermometers in wooden cases from 0°C - 100°C.

(f) Areometer in Be degrees from 0 - 10°Be; 10 - 30°Be; 30-70°Be.

(g) A few sets of beakers of glass and stainless steel, measuring beakers of plastic material, graduate cylinders of plastic material, test tubes, filter cloth, a few 50 ml and 25 ml pipettes, graduated pipettes from 0 - 25 and 0 - 10 ml, plastic funnels, glass rods, plastic spoons; further 6 reagent bottles with glass stoppers (for acids and salts) and 6 with rubber corks for alkalis.

(h) One semi-automatic precision balance for one kilogram load and one Berkel balance for 10 kilogram load.

(i) Electric cooker; electric stirring apparatus with metal stirrer for the preparation of finishing solutions.

(j) Dye-dishes of stainless steel and one experimental tanning drum made of plexiglass 40 cm. inner-diameter and 40 cm. inner-width with a capacity of 20 litres, speed 12 r.p.m. with 0.75 HP motor.

(k) One dry-wet-bulb hygrometer for measuring relative humidity.

This equipment is used also for the preparation of dye solutions and in tanning experiments.

7.1. As is shown in section 6, the processing of reptile skins requires careful control consisting of empirical, chemical and physical testing methods. These methods are outlined in the following paragraphs according to the sequence of processes and operations.

7.2. The lots entering production have to be sorted in the raw material store into skins of the same species, size and weight. Snake and lizard skins must not be mixed, but carefully selected according to length and width. This applies also to crocodile skins. Hornbacks must be processed separately from bellies, button-free bellies separately from buttoned ones. Small and large lizard skins must not be mixed together, as well as various quality grades.

7.3. Tests of completed soaking consist of empirical checking of softness and determination of soaking weight. Well-soaked skins should be as soft as they were after their removal from the animals' carcasses. Their weight after soaking should be about 300 per cent of the initial air-dried weight. The soaking weight of wet-salted crocodile skins is about 120 per cent - 140 per cent of the initial weight, depending on initial conditions.

7.4. Check liming on complete removal of the epidermal scales, connective tissues, fat and flesh after fleshing. Check crocodile skins for possible damaged grain ("sueded" grain) which may appear beneath the epidermal scale. Lime must completely penetrate the skin (check cross-section of specimen).

7.5. Deliming and bating. Deliming with weak acids and acid salts reduces the pH of the pelt from 12 to 8. At pH 8 the optimal condition for bating is created. (Check float and cut with indicator). The cut should be one third pink with phenolphtalein and the float between 7.8 - 8.3 pH. (Check with indicator paper). After addition of the pancreas bate, which contains also ammonium chloride or sulphate, a slight smell of ammonia indicates neutralization of the lime by the ammonium salts. The end of the bating is indicated by a colourless cut with phenolphtalein. Bated skins should be smooth soft and flaccid, so that the impression made by a finger remains due to reduced swelling ("falling"). By no means should pH drop below 4.5 as this will cause acid swelling of the pelt.

7.6. Check points in pickling are: the measuring of salt concentration, which should not be below 10°Be and after adding the acid pH of 3.5 - 3.8 should be attained at the end of pickling. By no means should the pickling concentration drop below 10°Be to avoid acid swelling which may decompose the skins. The pelts in cut should be yellowy-green with bromcresol green indicating a pH of between 3 and 4. The following sensory test may be

useful: properly pickled skins should be slightly rough on the surface, while smoothness indicates lack of acid. For depickling, check bath with indicator paper and cut with bromcresol green.

7.7 At bleaching, control bisulphite bath to be kept at pH below 4, use indicator paper.

7.8 Syntan-vegetable tanned skins are processed with an increasing concentration of tannin, which has to be checked by Be° before fresh dosages of extract are added. Concentration should be increased by 1° Be each day up to 4°Be. Check also the end pH which should be about 3.5 - 4. Dry out specimen of leather, if soft, tannage is completed, otherwise processing must be continued until results are favourable.

Chrome tannage is carried out by increasing pH up to pH 4. Check out with bromcresol green. Its colour will turn to bright-green. Completion of chrome tannage is controlled by the boiling test. Draw the outline of a 4 x 4 cm leather specimen on paper. Then put the specimen into boiling water for one minute and observe shrinkage by comparison with the outline on paper. Completely tanned leather does not shrink. A shrinkage of 10% may be tolerated if the specimen is not hard after the boiling test. If it is hard, tanning must be continued. Check neutralisation with indicator paper in the liquor and with bromcresol green in the cut. For chrome tanned leather liquor pH should be 7, the cut is to be blue indicating pH 6.

7.9 "Rub-fastness" of finished leather is tested by lightly rubbing a white felt pad, 1 cm. in diameter, on the leather surface. If the pad remains white after (ten times) rubbing, "dry-rub-fastness" is satisfactory. The same test is carried out by rubbing with a moistufelt pad. For solvent fastness, drop one ml of acetone on the flesh side of the finished leather and rub the grain side lightly with a dry felt pad ten times. Classify discoloration of the pad with 1, if the dye does not come away, 2 if slight, 3 if strong discoloration takes place. The repolishing test is carried out by rubbing a moist pad on the grain side. If the wet spot disappears when dry, without leaving a dull mark, the leather is considered re-polishable.

For more elaborate chemical and physical control, such as the determination of the basicity of chromium liquor, chromium content of the waste liquor, tan content of tannin extract, chemical analysis of finished leather, flexing

and other tests, the installation of a laboratory may be necessary.

The installation of an experimental tanning drum made of transparent plexiglass, as mentioned in paragraph 7.1 is advisable even in small reptile leather tanneries for conducting small-scale processing and standardizing dyeing methods.

VIII ECONOMIC ASPECTS OF REPTILE LEATHER PRODUCTION

8.1 A dominant item in the manufacturing expenses of reptile leather is the cost of raw skins which amounts to about 80% of the total production cost. The remaining 20% gives little room to the tanner to reduce production expenses and improve profitability. Reptile leather tanneries have to keep large quantities of crust stock on store, which ties up operating capital. Selling finished leather to a large number of small-scale footwear and leathergoods makers is a long term credit business which again increases capital requirements. The answer to the question of improving the production economy lies in the integration of primary production (leather) with secondary manufacturing (footwear and leather goods) in one unit, under one management. The necessity of integration has been fully recognised by the reptile tanners of the small island republic of Singapore, who have been associating their tanneries with corresponding leather goods manufacturing facilities, which have become the basis of Singapore's flourishing reptile leather trade. Integration has eliminated stock-piling of leather, reduced tied-up capital and converted long term credit business into cash business. After all, the final customers for footwear and handbags always pay in cash. In the following paragraph manufacturing cost and profit accounts of primary and integrated production are compared.

8.2 As representative for a small-scale model tannery, a monthly output of 2,000 pieces of lizard skins with an average width of 30 cm. per skin, is considered in the following example. The dry weight of 2,000 lizard skins is 200 kg., while their pelt weight is 600 kg. Rather the pelt weight than the number of skins is important as a denominator of outputs for various sorts of reptiles. For instance, the above output of lizard skins is equivalent to about 200 pieces of wet-salted crocodile skins which produce the same pelt weight of 600 kg. (i.e. 3 kg for one crocodile skin); or to 600 python skins 2-3 m long each, with 1 kg. pelt weight each. To process

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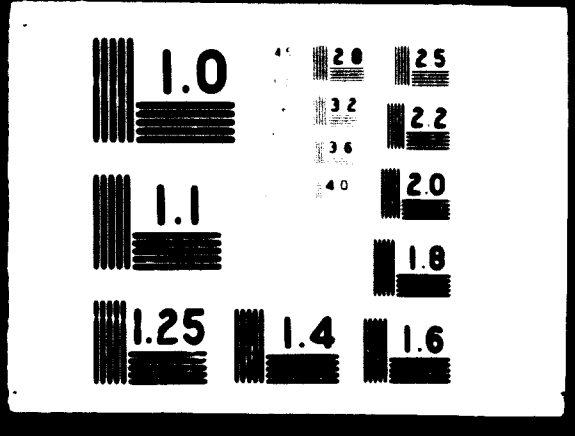


We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

this output into finished reptile leather 4 workers are necessary. Their monthly salary is calculated in this example at (Malayan Dollars) M$150 for one worker, which is above the average in the region of Malaysia and Singapore. Thus, the cost of direct labour is M$600 a month or M$.30 per lizard skin of the above size and weight. The manufacturing cost of one piece of lizard leather based on present local prices consists of:

(a)	One price of air-dried lizard skin 30 cm in width:	M$ 6.50
(b)	Chemicals for processing:	M$ 0.25
(c)	Direct labour:	M$ 0.30
(d)	Overheads, including indirect labour, depreciation, interest on capital etc.	M$ 1.25
(e)	Total manufacturing cost for one piece of lizard leather	M$ 8.30
(f)	Present sale price for export:	M$10.00
(g)	Profit per skin (f less e):	M$ 1.70
(h)	Profit related to manufacturing cost ($\frac{g}{e} \times 100$)	20.5%
(i)	Added value (profit plus direct labour cost) content for one skin (c + g)	M$ 2.00
(j)	Added value related to manufacturing cost ($\frac{i}{e} \times 100$)	24.1%

8.3 The economic pattern of production, however, improves considerably through the integration of primary and secondary production. One of the characteristics of the reptile goods trade is that customers usually prefer to buy so-called "sets" of products consisting of one pair of reptile leather shoes and one ladies' handbag in matching colours and design. For the production of such a set, four pieces of lizard leather of 30 cm. width (two for the shoes, and two for a handbag of about 28 cm width) are necessary. This means that the above output on our model tannery may provide reptile leather for 500 sets (500 pairs of ladies' shoes and 500 ladies' handbag) a month. Productivity in small-scale production is about one pair of completed ladies' shoes per worker per day, and one handbag per worker per day. This means that a monthly production of 500 sets requires the employment of 40 workers. Their salary is lower than in the tanneries, amounting to M$120 a month; thus the monthly salary account for direct labour in the leather goods unit is M$4,800 or M$9.60 per set (about M$4.50 for a pair of shoes and M$5.10 for one handbag). The production of 2,000 pieces of lizard

leather converted into 500 pairs of ladies' shoes and 500 ladies handbags (i.e into 500 sets), in one integrated, synchronized production unit is illustrated in the following table:

A)	Tannery production: (from paragraph 8.2 (a) to (d))	
	(a) four raw lizard skins, M$6.50 each	M$26.00
	(b) chemical cost for processing of four lizard skins	1.00
	(c) cost of direct labour	1.20
	(d) overheads, including indirect labour, depreciation, interest on capital and others	5.00
B)	Footwear and leathergoods production "one set":	
	(e) materials other than lizard leather, such as metal frames, locks, lining leather and other auxiliaries for one handbag	12.00
	(f) sole leather, lining and materials other than lizard skins for one pair of shoes	6.00
	(g) direct labour for one "set"	9.60
	(h) overheads	6.20
	(i) total manufacturing cost from raw skin to finished set A(a to d) + B (e to H)	M$67.00
	(j) estimated sale price for one set (M$40.00 for a pair of shoes and M$45.00 for one handbag)	M$85.00
	(k) profit per set (j less i)	M$18.00
	(l) profit related to manufacturing cost: ($\frac{k}{i}$ x 100)	26.9%
	(m) added value content per set (c + g + k)	M$28.80
	(n) added value related to manufacturing cost ($\frac{m}{i}$ x 100)	42.90%

Comparison between (A) and (B) shows an increase in profit from 20.5% (see (h)) to 26.9% (see (l)) and in added value from 24.10% (see (j)) to 42.90% (see (n)). The latter figure indicates the importance of integration from the point of view of national profitability.

8.4 A Reptile tannery, if producing for sale to manufacturers, has to keep in stock large quantities of semi-finished, crust stock, waiting for customers' orders for finishing. But integration eliminates this burdensome, capital-

consuming stockpiling, since the production programmes of the tannery and leathergoods departments, being under one management, can be streamlined, and the tannery informed well in advance of the sort of leather, colour and design it has to process. One of the most important advantages of integration is that the management can decide in advance what type of raw skins are most convenient for specific purposes, and is then able in this way to economize on this most expensive item in its calculations.

8.5 The above cost analysis is kept from the point of view of productivity on the lower side, while regarding salaries it is kept on the higher side, so as to assure some reserves in calculation. The item overheads consisting of M $5,000 and M $6,20 for leather (see (d)) and for leathergoods (see (h)) respectively, i.e. M $11.20 per set or M $5,600.- a month, provides sufficient funds for indirect labour, i.e. for paying adequate salaries for two technicians: one for the tannery and another for the products department, and for the few administrative staff. Depreciation is minimal, due to low fixed asset costs, since reptile leather and leathergoods manufacturing is a labour-intensive production, as will be shewn in the next paragraph. The sale price of M $85 for one set, consisting of M $40 for the shoes and M $45 for the handbag reflects local price conditions. For instance, leathergoods shops in Kualalumpur charge M $45 for the making of one set, i.e. one pair of ladies' shoes and one handbag, in matching design, if the customer supplies them with four pieces of lizard skins of 30 cm. width each. The customer may buy the four skins for M $10 each, therefore the set will cost him M $85.

IX. INVESTMENT AND PRODUCTIVITY

The nature of reptile tanning and leathergoods manufacturing favours the establishment of small-scale units. As a matter of fact, best quality leathergoods are not produced in large establishments but in small handicraft units in the Federal Republic of Germany and Italy. Reptile leather as a very expensive material may justify the cost of low-productive handicraft techniques without imparing profitability. Because of the peculiar shape of the reptile skins, highly mechanized techniques are not applicable. Therefore reptile leather goods are particularly suitable to small-scale production, with the emphasis on high-quality workmanship, colour and design, rather than on mechanization.

9.1 Using the above example of a monthly output of 2,000 lizard skins and the corresponding production of 500 sets of leather products (550 pairs of shoes and 500 handbags) as a representative standard, the following facilities are required.

9.1.1 A simple building of 150 sq. m for the tannery, one of 120 sq. m for the leather products section, one of 50 sq. m for raw material store, 50 sq. m for finished product store, 30 sq. m for the repair workshop and 50 sq. m for the administration building, in total 450 sq. m of floor space, costing in Malaysia M$70 per sq.m of a total of M$31,500.

9.1.2 Equipment for the reptile leather tannery consists of: two rotating tanning drums, 1.5 m in diameter and 1.25 m in width (internal measurements), with a float capacity of 840 litres each, further two paddle wheels 1.2 m in length, 1.1 m in width, and 0.70 m in depth with a float capacity about 1,000 litres each. One 300 mm shaving machine with reptile leather shaving attachment for both wet and dry shaving; two overshot rotating buffing wheels with dust collector; two leather glazing machines; one drying room for wet, one for nailed and one for finished leather about 10 sq.m each provided with an electrically-powered hot-air fan; one 2.5 x 1 m spraying unit with exhaust fan, air compressor and two spraying pistols; one rotating polishing wheel and one small hydraulic press with 50 cm x 50 cm ironing plate, electrical heating, timing device and adjustable pressure apparatus for up to 25 kg/sq.cm. Approximate c.i.f. cost:

(a)	two drums locally made, each M$3,000	M$ 6,000
(b)	two paddles locally made, each M$1,500	3,000
(c)	one shaving machine	11,000
(d)	two buffing machines locally made, M$600 each	1,200
(e)	two glazing machines, M$3,000 each	6,000
(f)	three electric heat-blowing fans, M$500 each	1,500
(g)	spraying unit (locally made), compressor and two spraying guns	1,500
(h)	rotating polishing wheel (locally made)	500
(i)	one electric water boiler 100 litres capacity	800

(j)	hydraulic, press 50 cm x 50 cm platen dimension	15,000
(k)	hand tools, tables, sundries	2,500
	Total:	M$49,000

9.1.3 Equipment for the leather products section:

(l)	one skiving machine	3,000
(m)	three sewing machines, M$2,000 each	6,000
(n)	one sole leather splitting machine	2,500
(o)	one sole press	3,000
(p)	tools	3,000
(q)	sundries (tables, shelves and others)	2,500
	Total:	M$20,000

The integrated project will consume 2,000 litres of water a day. Consumption of electricity will amount to 12 kw per hour or 96 kwh for a working day of eight hours.

Summing up investment into fixed assets:

Building costs	31,500
Equipment costs	69,000
Installation costs of equipment, electricty and water supply	17,500
Total fixed asset costs	18,000

(a) Depreciation of building (6 per cent): M$1,890 per annum, respectively: M$158 a month.

(b) Depreciation of equipment (10 per cent) M$8,650 p4r annum, (respectively M$820 a month)

Total amount of depreciation M$10,540 per annum or M$878 a month

9.2 The tannery section of the unit with 2,000 lizard skins (i.e. 600 kg pelt weight) output a month, and with four workers directly engaged in production, will have a worker-per-month output (8 hours work day) of 500 lizard skins, respectively, worker-per-day output (25 working days a month) of 20 lizard skins. Expressed in kg.pelt weight as the basic denominator of output for different types of reptile skins the role of production will be 150 kg per worker per month, or 6 kg per worker per day.

As mentioned in a previous chapter, the number of skins processed within a given pelt weight output is only vaguely related to their pelt weight per piece. For instance, the pelt weight of one 30 cm lizard skin is about 0.30 kg; that of a 2.5 m long Python skin about 1 kg, and the pelt weight of one crocodile belly of 38 cm width (15 inches) is about 3 kg. Within a given output of 600 kg. pelt weight a month - in vague relationship - 2,000 lizard skins, or 600 Python skins or 200 crocodile skins may be processed by the same number of workers (4 workers in our example). According to information obtained from France, a well-known crocodile tannery there produces 50,000 inches of crocodile skins a month with 50 workers. This quantity, related to our standard size of 15 inches for one crocodile skin, would amount to 3,333 crocodile skins a month, or 66 crocodile skins per month per worker, which is comparable wtih our above figure of 200 crocodile skins for 4 workers, (respectively 50 crocodile skins per worker per month). However, this output can only be attained if a shaving machine is available (as provided for in our example), otherwise, with manual fleshing, that may take 1 - 2 hours per skin, several times the number of workers would be needed.

The productivity in the leather product section is considered as one pair of shoes per worker per day and one handbag per worker per day, or 2 workers for one "set". This is rather a low output, particularly for shoes, but it is kept intentionally so in order to emphasise the quality. Very often higher productivity is achieved at the cost of the quality, which, in the case of expensive reptile leather, cannot be tolerated. The term 'set' in this context should be considered as a kind of denominator for a large variety of leather products manufactured within a given number of available man-hours. Productivity in terms of income can be considerably raised by utilising off-cuts of reptile leather, which usually appear in large quantities when producing main items, such as shoes and handbags.

X. PROCESS FORMULAE

The following processes described below are examples taken from the writer's practice in South-East Asia. The processes have been performed under the following climatic conditions: at a workshop temperature of 30 - 32°C; relative humidity of the atmosphrere: 67 - 70 per cent; temperature of water supply: 26 - 28°C.

10.1 White tannage of ring lizard and python snake skins with preserved natural markings

Material: Air-dried lizard and python skins, sorted into lots of the same species and sizes. Determine dry weight.

Soaking: The first soaking is carried out in a pit, vat or paddle, consisting of 2,000 per cent water (twenty times the dry weight of skins), 1 g/l of a fungicide and bactericide wetting agent (e.g. Mollescal C, Cortymol GB of BASF, or Cismolan BH of Bayer, or Diamoll C and F of Hoechst). It takes six hours without agitation. It continues for another 18 hours in a fresh float of the same volume made up to a 10°Be solution of sodium chloride (common salt), 2 g sodium sulphite (60/62 per cent in flakes) per litre, and 0.5 g/l of the above type of wetting agent. After 24 hours, paddle the stock for 2 hours, drain the float, put the skins in the drum, rotate without float for 30 minutes, rinse in running water for 15 minutes, check for softness, weight (soak weight).

Liming: Put the skins in a paddle containing 400 per cent of a 1°Be sodium sulphide solution (14 g sodium sulphide/l) and paddle the stock for 10 minutes every hour, excluding non-working hours (percentage calculated on soak weight). Total liming time 24 hours, check for complete removal of epidermal scales, drain float, rinse in running water for 30 minutes and handflesh over a beam if necessary. Determine pelt weight.

Bating: a) Lizard skins. Put pelts into a paddle containing 400 per cent water (calculated on pelt weight) of

35°C, 2 per cent Oropon ZR 2 (enzyme bate of Rohm & Haas Co.) and 2 per cent sulphated castor oil (e.g. Eukesol oil SF of BASF, for emulsifying natural fat). Agitate for 1 hour, check completion of bating (pH float 8.5, pelt must be soft and flaccid), then add 1.5 per cent Decaltal N (BASF, a non-swelling aromatic acid salt) to put down pH to 5. Paddle for 20 minutes and rinse in running water for 15 minutes.

b) Bate phyton skins as above but use only 1 per cent Oropon.

White tannage: Drum lizard skins, respectively, paddle python skins (preferable to drumming in order to prevent tangling) in a 300 per cent float of 1°Be solution of a lightfast replacement syntan, for 10 minutes in each hour, for 24 hours in all, excluding non-working time (Basyntan FLR, BASF, Tanigan 3LR, BAYER, Irgatan LV, Geigy). Strengthen syntan concentration by 1°Be daily until 4°Be is attained. Check completion of tannage on the fifth day by taking out one skin from the tan solution, rinsing and drying it out. The dried skin must be soft if tannage is completed, otherwise continue tanning at 4°Be. Shave on a machine if necessary, return to the tanning solution for 30 minutes, rinse for another 30 minutes in running water and proceed as for fatliquoring. The total consumption of syntan in 300 per cent float amounts to 56 per cent pure tan calculated on pelt weight. The syntan solution must be reused for tanning of subsequent lots of skins, so that syntan consumption will not exceed 20 per cent of pure tan calculated on pelt weight.

Fatliquoring: Use light-fast sulphated or sulphited natural oils (sperm oil, neat's foot oil, olive oil) or sulphated synthetic oil (Baykanol liquor T of BAYER, Derminol oils of Hoechst) which produce white emulsions. (Lipoderm liquor II of BASF is an oxidized and sulphited sperm oi; Coripol SO - 100 is a sul-

phated olive oil, particularly suitable for white leather. The addition of a light-fast raw fat such as coco fat is useful. For example, such a short-float fatliquoring formula consists of 6 per cent Baykanol liquor T, 2 per cent Corisol T - 100 and 2 per cent coco fat melted together at 60°C and emulsified with 30 per cent water at 50°C (percentage on pelt weight). Drum for 40 minutes, add 200 per cent water 45°, 3 per cent of one of above mentioned syntans and continue drumming for another 20 minutes. Pile up overnight without previous rinsing.

Drying: Hang the skins in a well-ventilated drying room at 40°C and dry. Store as crust leather at normal workshop temperature for 2 days.

Conditioning - nailing: Submerge crust skins in water for 5 seconds to obtain about 35 per cent moisture, nail with copper nails onto wooden boards and dry at 35°C - 40°C. The dried skins must be flat; without wrinkles and folds.

Finishing: Buff flesh side on an overshot rotating buffing wheel with No. 50 silicon carbide grain, trim and finish for glazing. Example for finishing solution: 160 g of a 10 per cent solution of Eukesol Lustra T (BASF, a casein product modified with synthetic resins), one fresh egg white, 20 g. Meluderm Wax Top PA (Hoechst, an anionic emulsified synthetic wax of medium hardness), 3 g Eukesol oil SF (BASF, sulphated vegetable oil), 3 g Eukesol oil P (BASF, polyglycol ether) made up to one litre with water. Pad or brush this solution evenly on the leather surface and dry. Spray fixing solution consisting of 250 g formaldehyde 40 per cent and 750 g water, which gives a 10 per cent formaldehyde solution; dry. Spray top season consisting of 150 g Luron top (BASF, condensed polyamide compound), one fresh egg white, 50 g of 1 per cent gelatine solution, 5 g

Eukesol oil SF, 5 g Eukesol oil P, 700 g water and 40 g formaldehyde 40 per cent. Try and spray final fixing solution consisting of 250 g formaldehyde, 700 g water and 50 g acetic acid 98 per cent. Try plate at 40°C, 20 kg/sq cm pressure, glaze, and plate again.

10.2 Processing of plain-white snake and lizard skins

Material and Soaking: as in 10.1

Liming: The same as in 10.1

Reliming: After de-scaling, fleshing and determination of pelt weight, relime the stock in a paddle with 500 per cent water, 10 g/l hydrated lime powder and 1 g/l Peliderm K (a Hoechst product, ammonium salt of amino-sulphonic acids which increases solubility of lime and accelerates liming at reduced swelling). Paddle 10 minutes every hour, reliming time 24 hours. Rinse in running water for 20 minutes.

Washing: Paddle in 500 per cent water with 0.5 per cent Tecaltal S (BASF product, a non-swelling strong aromatic acid with a mixture of an inorganic acid) until pH 8 is obtained.

Deliming: Relime thoroughly in 500 per cent water with 1.5 per cent Tecaltal N (a BASF product of an acid salt of a aromatic acid) for 30 minutes.

Bating: Paddle delimed pelts in 500 per cent water, at 35°C with 2 per cent Eukesol oil SF and 1.5 per cent Oropon PP for 60 minutes. Rinse for 10 minutes.

Bleaching: Drum with 400 per cent of a 10°Be solution of sodium sulphate for 10 minutes; add 0.1 - 0.2 per cent sulphuric acid, depending on the depth of pigmentation, and continue drumming for 5 minutes. Then add to the bath 8 - 10 g/l potassium permanganate and drum for about 30 minutes, until the skins have become dark brown due to the deposit of manganese dioxide. Drain the float and drum the skins in a fresh bath of 400 per cent float brought

with sodium sulphate to 10°Be and acidifying with 5 g/l Decaltal S to pH 3.5. After 10 minutes drumming add sodium bisulphite twice the amount of permanganate used in the previous bath, in three portions at intervals of 10 minutes. Add simultaneously Decaltal S to maintain the pH at 3.5. In total, about 15 g/l Decaltal S is used. Bleaching is completed when the pelts are completely white. Drumming time about 1.5 hours. Horse-up the skins overnight.

Depickling: Drum the bleached skins in 400 per cent solution of 10°Be sodium sulphate and increase pH to 5 by adding 2 - 3 per cent Neutrigen (a BASF product, alkaline buffer salt). Drumming time about 30 minutes. Check on maintenance of pH 5).

White tannage: The same as in 10.1

Fatliquoring: The same as in 10.1, only add 1 per cent Titanium dioxide or 1.5 per cent white pigment to the fatliquor.

Drying, conditioning, nailing: as for 10.1

Finishing: Prepare the following pigment solution: 50 g casein-free white pigment emulsion (e.g. BASF product, Lepton white B), 20 g Luronbinder U conc. (non-thermoplastic polyamide binder), 400 g water, 100 g Corialground ON (thermoplastic acrulic binder). Apply one plush coat, dry, spray two crosses, dry, plate at 50°C with 20 kg/sq. cm pressure. Spray with a solution of 100 g Corialwhite EM (BASF, pigmented nitrocellulose emulsion), Corial EM Finnish F (clear nitrocellulose emulsion) and 80 g water, then dry.

10.3 Processing of syntan tanned plain-coloured lizard and snake skins

Material up till White tannage: the same as in 10.2

Fatliquoring: Drum syntan tanned stock in 200 per cent water 40°C, 5 per cent Lipodermliquor 2 (BASF, sulphated

and oxidised sperm oil) and 1.5 per cent Immergan A (BASF, a mixture of sulpho-chlorinated synthetic paraffin hydrocarbon compounds which combines with the hide substance and has tanning and softening effect) for 30 minutes, then add 1.5 per cent Basyntan DLR powder and after 20 minutes 0.3 per cent otalic acid. Drum for another 10 minutes, horse up overnight, dry by hanging at 40°C, lay down as crust for two days, condition, nail on board, dry and buff flesh side. (Another fatliquoring formula may consist of: 2 per cent Derminol liquor ASN, 4 per cent Derminol liquor LMB (both Hoechst products, sulphated synthetic oils) and 3 per cent sulphated sperm oil). Determine dry weight.

Rewetting: Drum buffed leather with 1,000 per cent water 45°C and 0.5 per cent of a wetting agent (e.g. Nekanil LN of BASF, or Hostapal 2722 highly conc of Hoechst) for 2 hours then rinse.

Retanning: Drum rewetted leather with 600 per cent water and 10 per cent white tanning syntan, like Basyntan DLR powder for 30 minutes and rinse. (Percentage on dry weight).

Floatless dyeing, fatliquoring: Drum retanned wet leather without float with 3 per cent high quality anionic dye undissolved for light shades (while for dark-brown and black the chrome-retan tanning process is more suitable) for 30 minutes, then add 2 per cent - 5 per cent (depending on softness required) Lipodermliquor 2 (or similar sulphated neatsfoot or sperm oil) emulsified with twice the amount of hot water (50°C) and drum for another 30 minutes. Add to the bath 600 per cent water 45°C, drum for a further 30 minutes and then add 1 per cent formic acid diluted in 10 per cent water in three portions at intervals of 5 minutes, drum for 30 minutes more, drain, rinse, nail, dry and buff flesh side. All percentages refer to dry weight (see end of the paragraph "Fatliquoring").

Finishing: (a) A pure aniline finishing formula without the use of dyes in the finishing solution: (This method can be only applied to very evenly dyed lizard or snake skins (black excluded).

Apply plush-pad or brush coat on the flat, dry leather surface, a solution containing 10 g cationic casein (e.g. Eukanolgrounds A of Bayer) and 10 g cationic oil (Eukanol oil PI of Bayer) mixed together thoroughly then diluted with water at 40°C up to 1 litre. Dry at workshop temperature, plate at 35°C and 20 kg/sq cm. pressure for five seconds and apply by plush or brush coat the following anionic top season: 150 g Luron Top (BASF), one fresh egg-white 50 g gelatine 1 per cent solution, 5 g Eukesol oil P, 5 g Eukesol oil SM (both BASF products) made up with water to 800 g and add 50 g formaldehyde diluted with water to 200 g, altogether 1 l dry, glaze and plate at 45°C and 20 kg/sq. cm pressure.

(b) A pigment finishing formulae for unevenly dyed lizard and snake skins (except black):

Apply a plush or brush coat on flat dyed skins consisting of: 2[illegible] g transparent pigments (e.g. Sanil colours of Hoechst), 70 g Heluderm ZW (non-thermoplastic synthetic binder of Hoechst), 10 g Heludermwax top PA, 5 g Heludermoil S conc., 835 g water, 10 g. ammonia, 7[illegible] g Heluderm WT (all Hoechst products). Dry and spray the same solution, dry. Spray the following top season: 100 g casein solution 10 per cent, 100 g egg albumen solution 10 per cent, 3 g Heluderm oil S conc., 797 g water. Dry and fix 10 per cent formaldehyde solution brought to pH 3.5 with acetic acid, dry, glaze and plate at 60°C, 20 kg/sq. cm pressure.

(c) A pigment finishing formula for very unevenly dyed skins is as follows: 25 g Lepton colours (BASF, casein-free pigments), 60 g Luron Binder T, 15 g

Eukesol oil S, 20 g Lept n Wax A, 200 g water, 5 g rich quality anionic dye, 10 g Eukesol Binder S (BASF products). Apply pad coat, dry. Spray the same solution, dry. Spray top season as in (7), dry, fix, dry, glaze and plate.

10.4 Processing of plain-coloured lizard skins by the chrome-retan process (This process may be applied to all shades including black)

It results in softer leather than by syntan process and produces leather with higher heat resistance and with good glazing and plating properties.

Material until Bleaching: as in 10.2 and 10.3

Chrome pretanning: Drum bleached skins with 100 per cent water brought to 10°Be with sodium sulphate, 2 per cent Lutan B (BASF, a basic aluminium salt) and an alkali - stable chrome liquor containing 2 per cent Cr_2O_3 calculated on pelt weight and adjusted to pH 3.5 with sodium carbonate (Preparation of alkali stable chrome liquor is described in Chapter 11). Drumming time two hours. Raise the pH of the liquor to 4 by addition of 1 - 2 per cent neutrigen or the same amount of sodium bicarbonate in portions and drum for another two hours. Check that the pH remains at 4; if less, add more of the above alkalis. Leave skins in the chrome liquor overnight. Horse up for 24 hours, shave if necessary and determine shaved weight.

Neutralization: Drum chrome-tanned skins with 200 per cent water 35°C, 1 per cent neutrigen for 10 minutes, add 0.5 per cent sodium bicarbonate dissolved 1 : 10 in three portions at 10 minute intervals. Total drumming time one hour. Float pH 6 - 6.5. Rinse for 10 minutes in running water.

Retanning: Drum skins with 300 per cent water 35°C, 2 per cent sulphited sperm whale oil (e.g. BASF, Lipoderm Liquor 2), 1 per cent oxidized and sulphited fish oil (e.g. BASF, Lipoderm Liquor 1) and 1 per cent raw sperm whale oil for 20 minutes. Add 5 per cent replacement syntan (e.g. BASF, Basyntan P powder, or Bayer, Tanigan OSO), 10 per cent decolorized mimosa extract powder, 5 per

cent sumac extract powder and drum for four hours, leave skins in bath overnight. The concentration of the liquor should be 1.5° - 2°Be. Next day, drum for another hour, horse up for two days, rinse, hang to dry at 40°C, and determine dry weight.

Rewetting: Drum the dry stock with 300 per cent water at 35°C, 3 per cent Mollescal C or other wetting agent, and in the case of hard leather - with 2 per cent sodium sulphite, calculated on the dry weight. In most cases after one hour's drumming the skins are soft. Rinse.

Retannage: Drum dry skins with 500 per cent water and 10 per cent soft syntan (replacement for sumac) like Tanigan S, (Bayer) or Basyntan S (BASF) for three hours, then horse up overnight.

Dyeing and Fat-liquoring: for all shades except black. Both floatless and float processes can be applied. It is advisable to sew or staple the skins together at the edges (e.g. two lizard skins with flesh side inside) in order to prevent the skins from folding, which may cause uneven dyeing, leaving a dark line on the middle of the skins. For floatless dyeing add about 3 per cent high quality homogenous anionic dyestuff without dissolving and drum for 30 minutes then add about 4 per cent sulphited or sulphated natural or synthetic oils emulsified in 10 per cent hot water, and drum for another 30 minutes (e.g. 1 per cent Lipoderm Liquor 1, 3 per cent Lipoderm Liquor 2, 1 per cent Immergan A). Continue drumming for 30 minutes by adding 300 per cent water 60°C, and then add 3 per cent Formic acid 85 per cent diluted in 10 per cent cold water in 3 portions at intervals of 10 minutes. After the last portion drum for another 30 minutes, rinse, horse up overnight, nail on board, dry at 40°C, and buff flesh side.

Black dyeing: In the case of black dyeing, drum the rewetted and retanned skins with 600 per cent water at 45°C with 0.2 per cent sodium bichromate for 10 minutes, add 1 per cent Hematine (dye wood extract) and drum for another

10 minutes. Then add to the same bath 3 per cent high quality anionic black dye (e.g. BASF Lurazol Black VB or Bayer Chrome Leather Fast Black PV or others) in 3 portions at intervals of 10 minutes. Add fatliquor e emulsion consisting of 4 per cent sulphated or sulphited oils (e.g. BASF lipoderm Liquor 1 and 2 or Hoechst Terminol Liquor EMB and ASN or others) and 1 per cent raw oil (raw neatsfoot oil or Stockhausen's Coripol ICA) and drum for 40 minutes. Acidify the solution with 3 per cent formic acid 85 per cent added in 3 portions at intervals of 10 minutes. After the last portion, continue drumming for 30 minutes, then rinse. Prepare a fresh bath for basic tapping: at first drum with 600 per cent water 45°C, 1 per cent cationic dyeing assistant (e.g. BASF Lipamin Liquor O or Stockhausen's Eucoriol KSP) for 20 minutes. Add a solution of 0.5 per cent basic dye. (e.g. BASF Leather Black MB) made to a paste with the same amount of acetic acid 30 per cent and diluted with 10 per cent water, drum 30 minutes, horse up overnight, nail, dry, and buff flesh side.

Finishing: For all shades except black, see glazing finishes as for pure aniline, dyed and pigmented finishing in Chapter 10.3, at A), B), C).

Finishing, black: Pad dried and buffed leather with the following cationic base coat: 100 g Eukanol Ground A (BAYER) mixed with 10 g cationic Eukanol oil PL (BAYER) and 4 g Basic black dye (e.g. Leather Black MB of BASF) pasted with 4 g acetic acid 30 per cent and dilute to 1 : 1. Dry and spray the following anionic finish, consisting of 160 g 10 per cent Eukesol Lustre M (BASF, with synthetic resin modified casein product, soft type), 1 egg white, 20 g Meluderm Wax Top PA (Hoechst) 8 g Negrosine WLA conc. (BAYER) 2 g Erganil Violet B (BASF) diluted with water to 1 litre. Dry, fix with 10 per cent Formaldehyde solution, dry. Spray top season consisting of 150 g Luron Top (BASF),

1 egg white, 50 g 1 per cent solution of gelatine, 5 g Eukosol oil F (BASF) 5 g Eukosol oil SF (BASF) diluted to 600 g and add 30 g formaldehyde diluted with 200 g water (total one litre). Dry, fix with the following solution: 250 g formaldehyde 10 per cent, 700 g water, 50 g acetic acid 48 per cent, dry, plate at 60°C and 20 kg/cm^2 pressure, for 3 seconds, glaze and plate again.

Plyurethane finishing: Used for all shades including black. This is a pigment-based finish particularly suitable for unevenly dyed or slightly damaged reptile skins. In the following example finishing materials of the Stahl Chemical Company in Holland are used. Apply pad coat of the following composition: 100 g Torotex pigment mixture (available in any shade), 40 g Luron Binder U (BASF, non-thermoplastic binder), 100 g Resin EX-1, 40 g Resin 1173, 20 g Filler RB-65A, diluted with 250 g water (all materials except Luron Binder U are Stahl Products). Dry, spray with the same finishing solution, plate at 80°C, 20 kg/cm^2 pressure. Spray on the plated leather the following polyurethane top season: 100 g Permuthane U - 106, 3 g Permuthane U - 601 (catalyst), 5 g Permuthane U - 109 (plasticizer). Dry and plate at 80°C, pressure 20 kg/cm^2. Particular precautions must be taken to prevent the top season from coming into contact with water. If this happens, the solution solidifies and cannot be used. In most environments, about 10 per cent methlycyclohexanone may be added to the top season. The spraying pistol should be completely dry and moistened with methylisobutyketone, urethane grade.

10.5 Processing of plain-coloured python and other snake skins for soft garment (Nappa) leather

Material - until Bleaching: as in 10.2 and 10.3

Chrome tannage: For the tannage of this type of leather, an alkali-resistant (masked) chrome liquor is used, the prepara-

tion of which is described in Section 12. Repickle the skins after the bisulphite bath (following the permanganate bath) to pH 4.5 by drumming in a 10°Be sodium sulphate solution (300 per cent of the pelt weight) for 10 minutes and adding 1 - 2 per cent sodium thiosulphate. Drum the depickled pelts with 50 per cent water and a 33 per cent basic chromium solution (alkali resistant) containing 1 per cent Cr_2O_3 (on pelt weight) for 60 minutes. Add to the same bath 1 per cent Cr_2O_3 containing chrome liquor of 45 per cent basicity; after another 60 minutes drumming, again 1 per cent Cr_2O_3 of 50 per cent basicity, drum for another hour and adjust the pH to 4 with neutrigan. Continue drumming until the leather stands the boiling test. Horse up overnight, shave on the shaving machine and weigh. (Extended chrome tanning).

Washing: 100 per cent water with 0.2 per cent acetic acid at a concentration of 30 per cent (6°Be) for 10 minutes and rinse in running water.

Nuetralization: Drum with 600 per cent water at 30°C with 1 per cent neutrigan for 20 minutes. Add 1 per cent sodium bicarbonate and drum for another 30 minutes, rinse for 10 minutes.

Dyeing: Drum in fresh float with 800 per cent water at 50°C, and with 2 per cent high quality anionic dyestuff for 30 minutes. Add 5 per cent sulfited or sulfated sperm oil (e.g. 5 per cent Lipoderm Liquor 2) and rotate for 30 minutes. Add as much formic acid 85 per cent until pH4 is obtained. The leather must be dyed through its cross section. Formic acid should be added diluted, slowly, in portions. Drum for a further 30 minutes, rinse for 10 minutes. Horse up overnight, nail out to dry, or vacuum dry.

Finishing: Apply plating finish by spraying with a solution consisting of 50 - 60 g covering pigment (to match the shade of drum dyeing accurately), 30 g Luron binder (BASF, non thermoplastic binder), 20 g of an emulsified

synthetic wax with a matting agent (e.g. Eukesol Top Matt of BASF), 500 g water, 100 g of an acrylic thermoplastic binder (e.g. Corial binder OHN). Dry, plate at 50°C and at a pressure of about 15 kg/sq. cm. Spray again with the same solution, dry. Spray the following top season: 100 g, nitrocellulose emulsion (e.g. BASF Corial EC Finish F), 20 g water, 10 g of a polyacrilic emulsion as filling agent (e.g. BASF, Leatherground F), 5 g of an acrylic based aniline dyed resin in matching shade (e.g. BASF, Corial aniline resin) and 20 g formaldehyde. Dry and polish on a rotating plushwheel.

10.6 Snake skin garment leather with natural pigmentation

Material - Deliming and Bating: as in 10.5

The process is similar to 10.5 with the exception that the pelts are not bleached in order to maintain their natural markings.

Pickling: Bated skins are pickled in drum with 300 per cent float calculated on pelt weight, brought to 10°Be with sodium sulphate. After 10 minutes drumming, add 1 per cent formic acid 85 per cent, diluted with water in a ratio of 1 : 1 and drum for one hour until pH 4.5 is attained.

Chrome tannage: Full chrome tannage with 3 per cent Cr_2O_3 in portions with increasing basicities from 33 per cent until 50 per cent, as described in 10.5 (Extended chrome tanning).

Neutralisation, dyeing (if necessary), fatliquoring, drying: as in 10.5

Finishing: Buff flesh side of leather, trim and apply on the grain side the following glazing finish: 70 g Meluderm 70 (Hoechst, internally plasticised, slightly thermoplastic but still glazeable, copolymer), 10 g Meluderm - Wax stop PA (Hoechst, anionic emulsified synthetic wax) 5 g Meluderm oil S (Hoechst, sulphated synthetic oil) 385 g water, 10 g ammonia 25 per cent and 70 g Meluderm WF (Hoechst, a glazing binder, organic condensation product containing amino groups). After

plush coat, dry and spray the same finish, then dry and glaze on the reptile leather glazing machine. Finally, spray the following top season: 100 g glossy nitrocellulose emulsion (e.g. BASF Corial E' Finish F), 50 g water and 20 g formaldehyde 40 per cent. Dry and plate at 60°C at a pressure of 22 kg/sq.ft.

10.7 Processing of 'buttoned' crocodile bellies in dark and black shades

Material: Wet salted crocodile bellies

Soaking (I): 500 per cent water for 2 hours, paddle intermittently.

Soaking (II): 500 per cent water, 0.2 per cent Collescal C for six hours paddling intermittently. Flesh by hand with fleshing knife, if necessary.

Liming: 300 per cent water, 3 per cent sodium sulfide (60 - 62 per cent), 3 per cent hydrated lime powder, for 3 days, paddling intermittently. Rinse for 15 minutes, descale, flesh and determine pelt weight.

Deliming - Bating: 500 per cent water 30°C, 1 per cent Decaltal N powder (BASF, non-swelling aromatic acid salt). Paddle for 10 minutes. Add 1 per cent Oropon OR, 10 per cent water, and continue paddling for 4 hours with several resting periods. Rinse for 10 minutes.

Button-Softening Pickle: 500 per cent water adjusted with sodium sulphate to 10°Be. Paddle for 10 minutes and add 10 per cent hydrochloric acid diluted with water in a ration of 1 : 10. Paddle intermittently and leave in the bath for 24 hours. Add again 10 per cent hydrochloric acid and leave for 24 hours, and finally another 10 per cent hydrochloric acid and leave for 24 hours. (Altogether 30 per cent hydrochloric acid for three days).

Depickling: Paddle the skins in 500 per cent float adjusted with sodium sulphate to 10°Be, leave in the solution for 36 hours. Add 2 per cent sodium acetate and paddle for 15 minutes, then 1 per cent sodium bicarbonate and paddle until pH 4 is attained.

Chrome Pre-tannage: Drum in slowly rotating drum (8 r.p.m.) with 150 per cent water, 5 per cent sodium chloride (common salt) and 8 per cent chromium sulfate powder containing 25 per cent Cr_2O_3 of 33 per cent basicity. (e.g. Chromitan B of BASF, or Chromosal B of BAYER). Drum for 3 hours, leave pelts overnight in the float and basify next day by adding 2 per cent Basyntan P powder (neutral syntan of BASF), which will bring the pH up to 4. Horse up overnight and shave on the flesh side until it is free of 'buttons'. Determine shaved weight.

Neutralization: Drum in 100 per cent water at 35°C, 0.5 per cent Neutrigan (BASF, slightly alkaline buffering salt) for 10 minutes. Add 1 per cent sodium bicarbonate in 3 portions at intervals of 10 minutes, continue drumming for another 30 mirutes. Check pH of the cross section. It should be pH 4.5 (with bromcresol greenish-blue).

Fatliquoring and retannage: Drum for 20 minutes in 150 per cent water 40°C with an emulsion prepared from 2 per cent Lipoderm Liquor 2, (BASF, sulphited sperm oil), 1 per cent Lipoderm Liquor 1 (BASF, oxidized and sulfited fish oil), 1 per cent raw neatsfoot oil. Then add 0.5 per cent formic acid 85 per cent, 5 per cent water, 10 per cent decolorized mimosa extract powder, 5 per cent Basyntan J powder (BASF, syntan) and drum for 2 days intermittently, 10 minutes each hour, except in non-working hours. Check completed tanning by drying out a specimen. It must be soft. Horse up for 24 hours, wash, and dry sharp at 50°C. Condition and hand stake, store for a few days.

Dyeing: Rewet dry stock with 1,000 per cent water at 35°C by drumming for 30 minutes. Rinse, dye in drum in a float of 1,000 per cent water 40°C and 2 per cent high quality anionic dyestuff (Lugunil Brown NR for brown, Lurazol Black VBfor black, both BASF products), drum for 20 minutes and add an emulsion consisting of 1 per cent Lipoderm Liquor, 1.2 per cent Lipoderm

liquor 2, and 1 per cent Immergan 1 (all BASF products). Immergan 1 is an aliphatic sulpho-chloride, water soluble oil). Drum for 30 minutes, add 2 per cent formic acid 85 per cent, drum for another 30 minutes and rinse.

Basic topping: Drum in a fresh bath consisting of 1,000 per cent water, 1 per cent Lipamin OK (BASF, cationic dyeing agent) 1 per cent Lipamin Liquor O (BASF, cationic fatliquor). After 10 minutes drumming, add for dark brown 0.2 per cent Chocolate Brown BG pasted with the same amount of acetic acid 30 per cent. For black: add 0.5 per cent Leather black HF pasted with the same amount of acetic acid 30 per cent (both BASF, basic dyestuffs). Drum for 30 minutes. Rinse, nail, dry at 50°C, buff flesh side and trim.

Finishing brown: a) Base coat: apply 1 plush pad coat of the following solution: 100 g Luron Top, 2 g raw linseed oil, 5 g Eukesol oil P, 5 g Eukesol oil SR. 50 g fresh ox blood, 50 g gelatine solution 1 per cent, 2 g Luganil Brown BR, 1 g Luganil Brown M3G (BASF dyes) 785 g water. Dry, spray 2 crosses of the same finishing solution, dry, glaze, overspray a solution of 30 g Eukesol Binder S in 1 litre water. (BASF - a colloidal aqueous alcoholic polyacrylic solution for levelling out grain faults). Dry.

b) Top lacquer season for brown: Prepare the following organic solvent solution: 100 g Corial Lacquer XS (BASF, nitrocellulose lacquer), 3 g Plastamol DOA (BASF, an ester of adipic acid, softener for nitrocellulose lacquer), 50 g Butyl acetate 85 per cent, 50 g methylanon, 150 g corial Diluent A, (BASF an ester solvent based on isobutylacetate) and 20 g Isanol. Spray one coat and dry.

Note: The organic solvents used in the top lacquer season are mixed according to evaporation time and boiling range. Evaporation time is a relative number referring to evaporation of diethyether as No. 1. It is carried out by moistening a piece of filter paper with the

solvent to be tested and by measuring the time it takes until it completely evaporates. Particularly in a humid tropical environment it is essential to select solvents of nitrocellulose lacquers with suitable evaporation times. Too slow an evaporation process results in dull appearance of the film, high evaporation time makes the lacquer film more glossy, but drying will take longer, the film may become tacky and may absorb dust from the surrounding atmosphere. The danger of dull, patchy or milky appearance of collodium films on leather is due to solvent mixtures which evaporate too fast, connected with the absorption of humidity that will precipitate nitrocellulose. The addition of 10 - 15 per cent butylalcohol may minimise this danger.

Name of solvent	Evaporation Time	Boiling Range in °C
Acetone	2.1	55 - 56
Butylacetate 85 %	12.5	110 - 132
Butylalcohol (n-Butanol)	33	114 - 118
Methylanon 85 %	50	165 - 176
Corial Siluent A	8.5	111 - 118
Isanol	27	104 - 118

Finishing Black

A) Basecoat: Apply one plush pad consisting of 100 g. Gelatine 1 per cent, one fresh egg white, 840 g. water, 2 per cent Lurazol Deep Blue EF, 1 g Eukesolarviolet. (Luron Top and dyes, BASF products). Dry, spray two crosses of the same solution, dry, glaze, overspray with a solution of 30 g Eukesol binder S (BASF, see above) in 1 litre water, dry.

B) Top lacquer season for black: Spray with a solution of: 50 g Corial lacquer XS (BASF, see above), 50 g Corial black lacquer (BASF, nitrocellulose lacquer coloured with black dye). 3 g Plastanol DOA (BASF, softener), 50 g Butylacetate 85 per cent, 50 g Methylanon, 150 g corial diluent A, (BASF, see above), 20 g Isanol. Dry.

10.8 Processing of crocodile leather in bright shades

Material until Deliming and Bating: see 10.7

Bleaching: For light shades crocodile pelts should be bleached with permanganate and bisulphite as described in 10.2

Pickling: If the crocodile bellies are "buttoned", the 30 per cent hydrochloric acid pickle should be used as described in 10.7 as Button-Softening Pickle. In the case of button-free bellies, normal pickling procedure can be applied as described in the chrome retan process for lizard and snake skins as in 10.4. For chrome-pretannage, fatliquoring and retannage, dyeing, basic topping, finishing A) and B) see 10.7. Use dyes of the required shades. Do not use oxblood in the base coat for bright shades.

10.9 Chrome tannage for processing crocodile skins with moulded ('Bombe') effect in all shades.

After the usual pickling procedure apply the extended chrome tanning process with 3 per cent Cr_2O_3 as described in the process for garment snake skins in 10.5. The tanned crocodile skins must stand the boiling test. Horse up overnight, shave and weigh.

Washing: Paddle for 10 minutes in 100 per cent water and 0.2 per cent acetic acid 30 per cent rinse for 5 minutes.

Neutralisation: Drum in 200 per cent water at 35°C, with 0.5 per cent Neutrigan for 10 minutes, add 1 per cent sodium bicarbonate in 3 portions at intervals of 10 minutes. Total drumming time 1 hour. Rinse for 10 minutes. The pH in the cut should be 4.5.

Retannage: Drum in 300 per cent water at 35°C, with an emulsion mixture of 2 per cent Lipoderm Liquor 2, 1 per cent Lipoderm Liquor 1 (both BASF products), 1 per cent raw sperm oil and 10 per cent water. After 20 minutes add 6 per cent Tanigan OS powder (BAYER, replacement tannin extract, yielding almost white leather) and 2 per cent decolorized mimosa extract powder. Agitate for 4 hours, and leave in the bath for overnight. Check dry specimen for softness. Horse up for 24 hours, wash and dry sharp at 50°C. Condition, hand

stake, and store for a few days.

Dyeing: Select high quality anionic respectively basic dyes according to the required shades. Procedure as in 10.7. After rinsing nail leather in slightly stretched state and dry at 100°C, whereby the scales will obtain moulded, convex shape. Shave flesh side on the dry-shaving machine.

XI. PREPARATION OF ALKALI-STABLE BASIC "LACTATE-MASKED CHROMIUM SULPHATE LIQUOR"

This is a self prepared chromium liquor made by reducing sodium bichromate with molasses or glucose, in presence of sulfuric acid. Alkali-stability is achieved by 0.5 mole sodium lactate for 1 mole Cr_2O_3 added in the completely reduced and still hot chromium bath. The preparation of 45 per cent basic chromium sulfate liquor is carried out as follows: Use a wooden vat with a lead lining, 1,000 litres in volume, for the reducing. Put into the vat 100 kg sodium bichromate, 100 litres cold water and 88 kg sulfuric acid 66°Be (96 per cent sulfuric acid content). Prepare a solution of 40 kg molasses or glucose in 100 litres water and add it slowly through a funnel continually stirring the liquor. The reaction is very vigorous and heat-producing. Check complete reduction of the red bichromate solution (containing 6-valent Cr) to the green chromium sulfate solution (containing 3-valent Cr) as follows: dilute in a test tube a few drops of chromium solution with water, add a few drops 25 per cent sulfuric acid, 0.5 cc diethyl ether and 0.5 cc hydrogen peroxide (6 per cent H_2O_2 content). A blue colour in the ether layer indicates the presence of bichromate, in which case the reduction must be continued. A colourless ether layer indicates complete reduction. Add to the hot and completely reduced chrome liquor sodium lactate, which may be prepared by mixing equivalent quantities of lactic acid and sodium hydroxide. As 100 kg bichromate contain 50 kg Cr_2O_3, neutralize 15 kg lactic acid (based on 100 per cent lactic acid content) with 6.7 kg sodium hydroxide (on 100 per cent basis). The reaction of this solution, which now consists of sodium lactate, is slightly alkaline, at about pH 8. Add this solution to the hot reduced chrome liquor and leave it for 24 hours. Test alkali stability by diluting in a test tube a few drops of chromium solution with water, then add several drops of a 15 per cent sodium carbonate solution to increase

pH to 7. No precipitation will occur. The Cr_2O_3 content of the chromium solution can be easily calculated from the volume of the liquor and its content of Cr_2O_3. The concentration of the chrome liquor is between 30 and 40° Be containing 150 - 200 g Cr_2O_3 per litre. Its basicity will be slightly above 45 per cent due to the alkaline reaction of sodium lactate.

Any commercial chromium sulphate product may be adjusted to alkali stability by the addition of 3.5 mole sodium lactate for 1 mole Cr_2O_3. For instance: Chromosal B (25 per cent chromium oxide content) can be made alkali stable in the following way. Dissolve in a vat 200 kg. Chromosal B in 100 l hot water. Add sodium lactate solution by mixing 15 kg lactic acid (based on 100 per cent lactic acid content) with 6.7 kg sodium hydroxide (on 100 per cent basis). Stir and leave it overnight. Now the chromium liquor is ready for use.

The advantage of such alkali-stable (masked) chrome liquor is that it will not precipitate during the tanning process or afterwards, when the leather is horsed up, even at pH 6 or 7, while all normal commerical chromium salt solutions precipitate at pH 5.

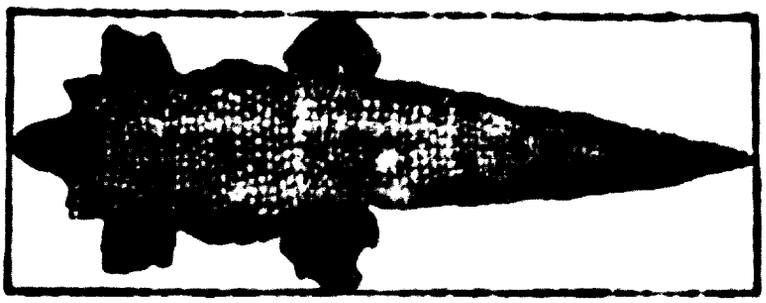


Figure 1. Properly flayed crocodile belly.

Figure 2. Proper ripping line to flay a crocodile.

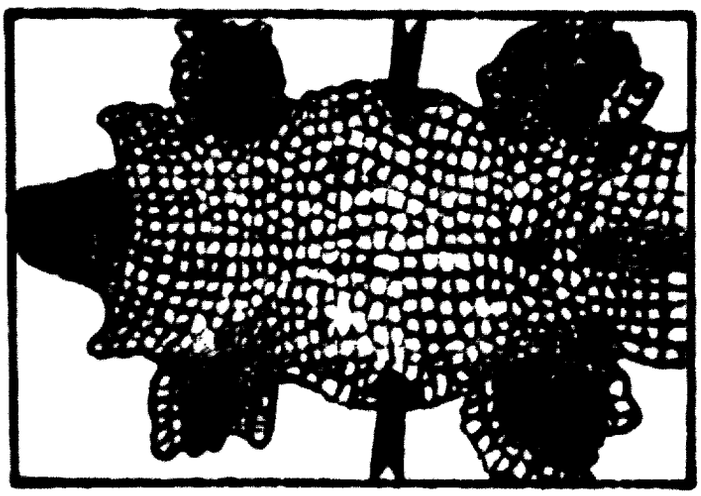


Figure 3. Crocodile skins are measured across the widest part of the belly.

ANNEX I

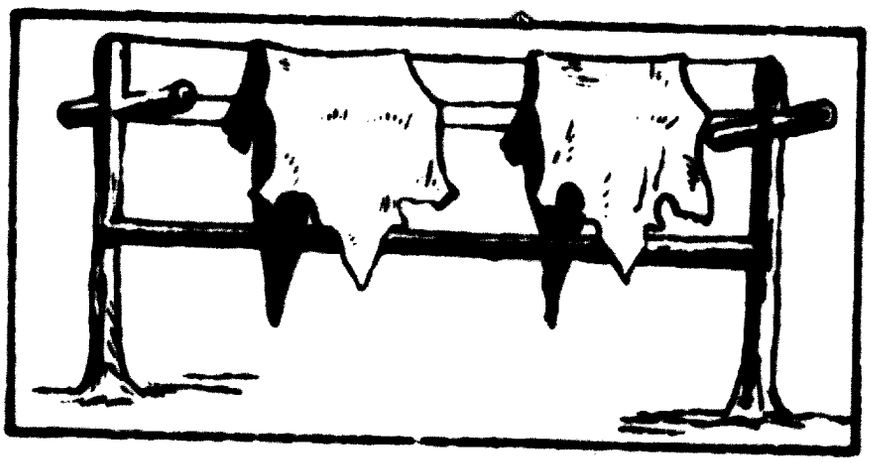
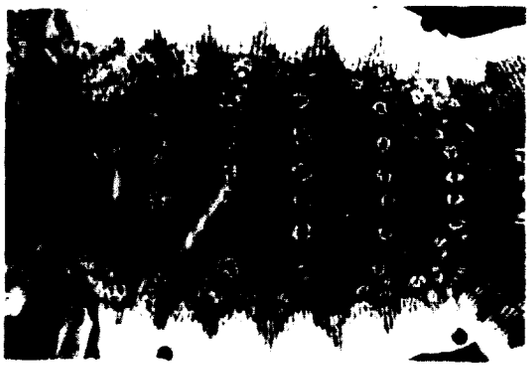
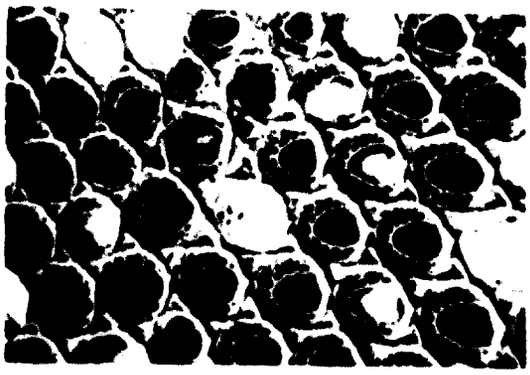


Figure 4. Draining rack for crocodile skins.

Figures 1. - 4. From FAO Development Paper No. 68, "Rural Tanning".

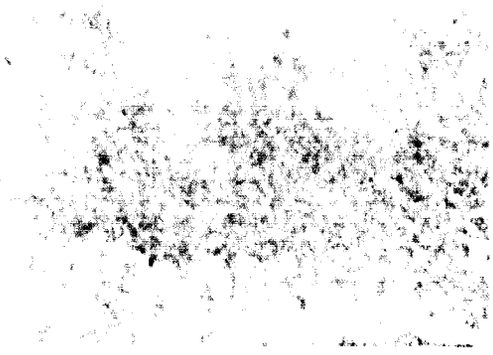


JAVA LIZARD , BIAWAK.
(Varanus Salvator)

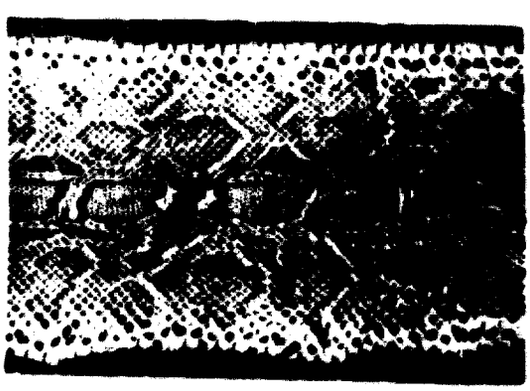


AFRICAN (Prairie) LIZARD
(Varanus Exanthematicus)

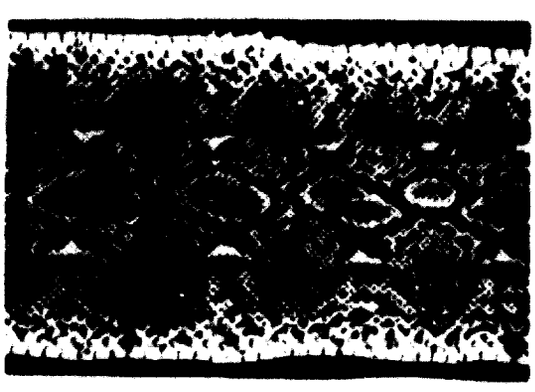
THORNTAIL LIZARD
(Uromastyx Egypticus)



TEJU PROPER
(Tupinambis Tejuixin)

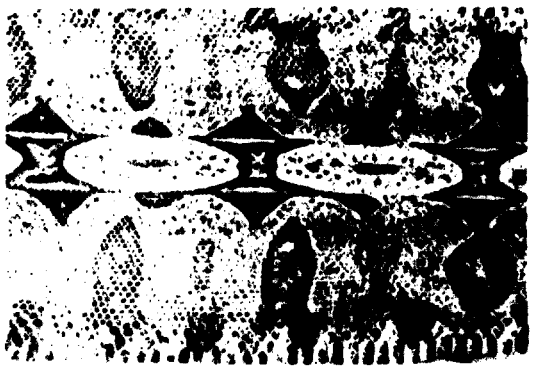


TIGER PYTHON
(Python Molurus)

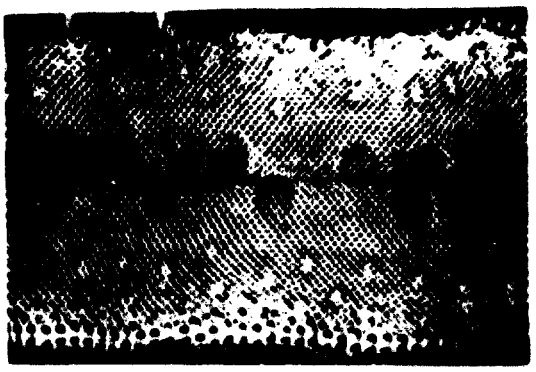


DIAMOND PYTHON
(Python Reticulatus)

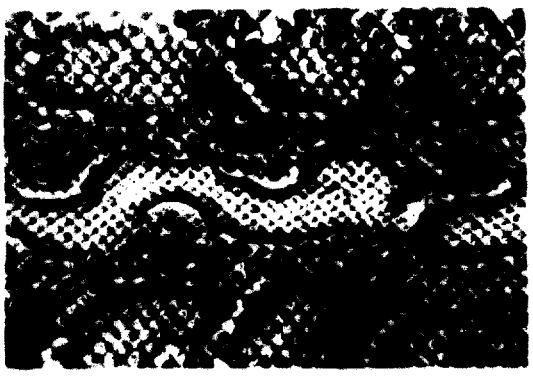
ANNEX II



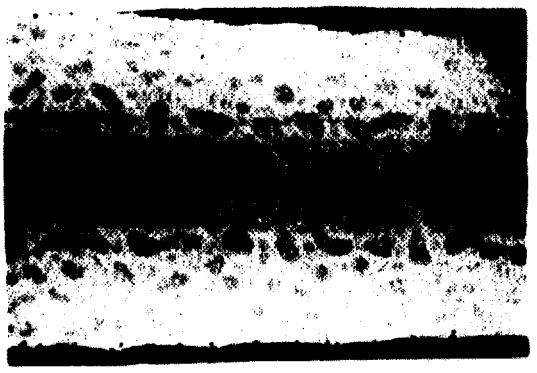
GIBOYA SNAKE
(Boa Constrictor)



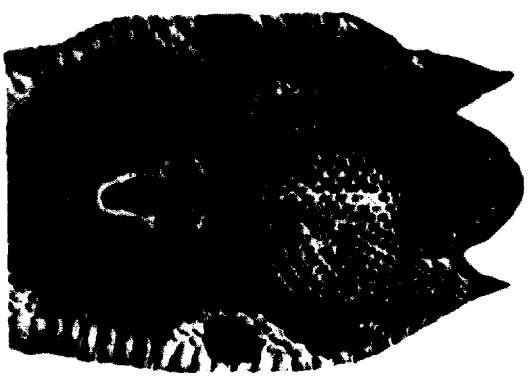
ANAKONDA SNAKE
(Eunectes Murinus)



ROCK PYTHON
or
HIEROGLYPH SNAKE
(Python Sebae)

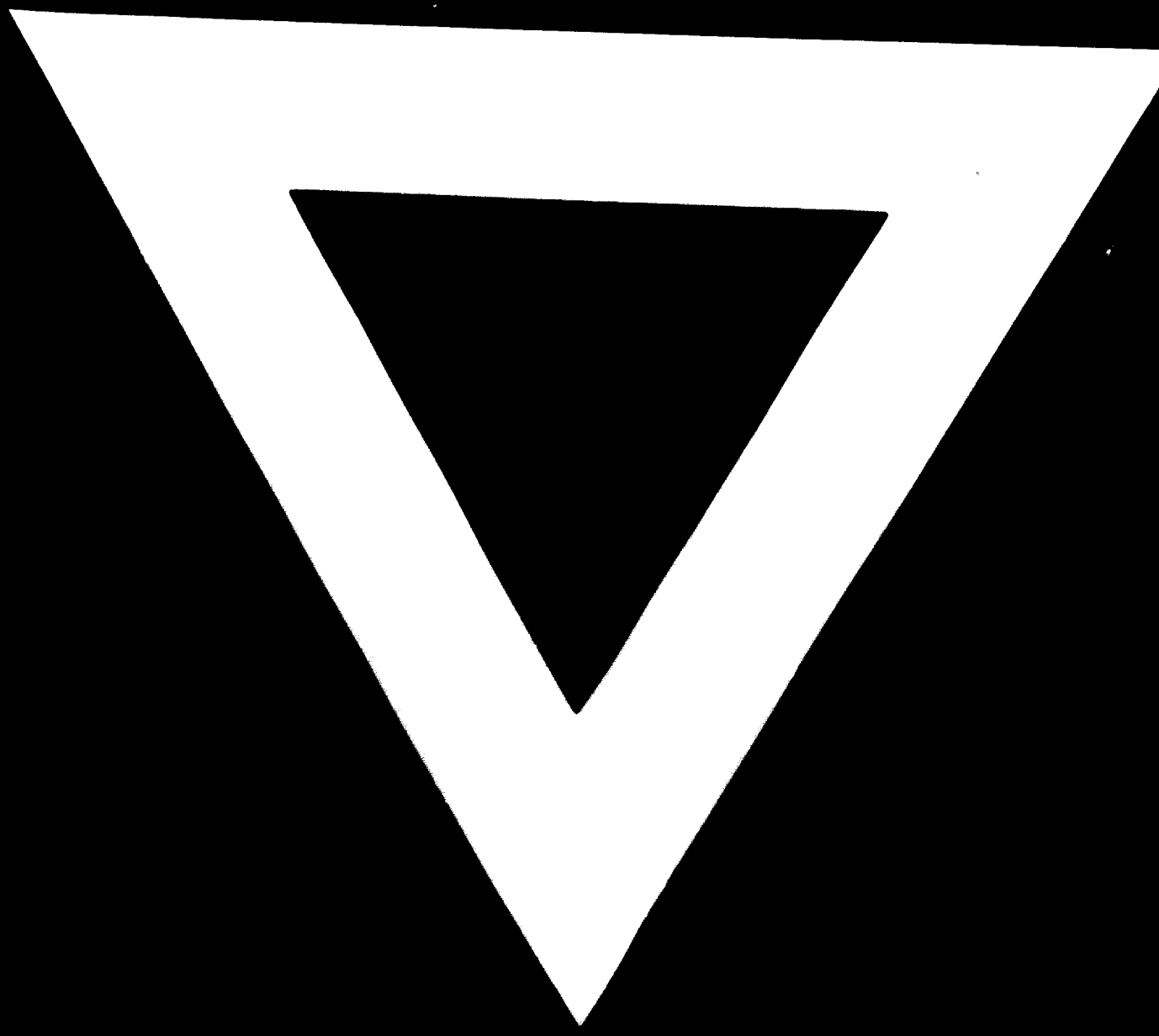


KARUNG SNAKE
(Acrochordus Javanicus)



COBRA SNAKE
(Naja Naja)

WHIP SNAKE
(Ptias Mucosus)



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