

White Pelicans *Pelecanus onocrotalus* breeding on the Etosha Pan, South West Africa, during 1971

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I. ABSTRACT

White Pelicans *Pelecanus onocrotalus* were recorded breeding on the Etosha Pan for the first time in 1971. The breeding colony of c. 3 000 pairs was situated on flat, dry ground. The nearest water for fishing was 100 km distant, at Lake Oponono, and the pelicans used lifting air thermals to glide there and back. Disturbances elsewhere caused the pelicans to abandon two earlier nesting attempts and were probably the reason why they chose the isolation of the Etosha Pan. An attempted rescue of some chicks, when significant mortality occurred near the nests, was largely unsuccessful. Notes on nests, eggs, behaviour of adults and young, scavengers and presence of insecticides in the eggs are given. The fledging success of young hatched was 40 per cent. In addition the status of *P. onocrotalus* in SWA is discussed.

II. INTRODUCTION

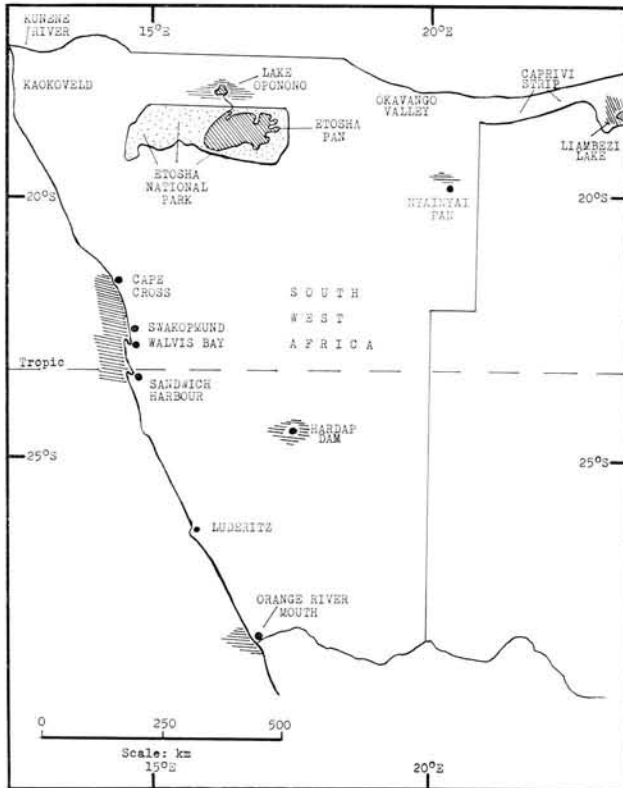
White Pelicans *Pelecanus onocrotalus* Linnaeus normally occur in the Etosha National Park when the main pan and its contributing rivers flood sufficiently to provide a temporary food source. Fish from adjoining perennial lakes and watercourses are swept along the rivers and appear in considerable numbers in the Etosha Pan.

McLachlan and Liversidge (1970) record Etosha as one of several breeding grounds of *P. onocrotalus*. This is apparently a reference to the general area; the actual breeding record comes from Lake Oponono (Winterbottom 1969) which lies north of Etosha National Park, in Owambo. This is probably the lake to which Andersson (1872) refers as "Lake Onondava" and where he encountered *P. onocrotalus*. The species was recorded in the precincts of the Pan in 1963 (Winterbottom 1964) and was only known to breed in Owambo during the months of August (Winterbottom 1971). In 1971 the first record of *P. onocrotalus* breeding on the Etosha Pan was obtained. It is also the first mass breeding record for the species in South West Africa.

III. STATUS OF WHITE PELICAN IN SOUTH WEST AFRICA

Andersson (1872) records the species at Walvis Bay, Sandwich Harbour and Lake Onondava (L. Oponono). In those times he considered that the White Pelican did not breed at the coast but migrated inland to nest.

The erection of the guano platform on "Bird Rock" in the Bay of Walvis in 1932 doubtless provided the isolation which is necessary for pelicans to breed successfully (Fig. 1). Since then it has become a regular breeding ground for White Pelicans and other birds (Logan 1960). Rand (1963) recorded pelicans and their young on the platform in No-



Map 1. Distribution of White Pelican in South West Africa.

vember 1956 and the concession-holder has observed the pelicans nesting since 1950 (Groenewald, pers. comm.). During three seasons (1969–1971) HHB observed that they commence egg-laying in September with the first young fledging in January. In all three seasons between 200–400 chicks hatched annually. White Pelicans have not been known to breed on the other man-made guano platforms at Swakopmund and Cape Cross.

On the coast between Sandwich Harbour and Cape Cross (Map 1) the numbers approach 1 000 adult birds, the most concentrated gathering grounds being at Walvis Bay. Here the wastage of fishing trawlers and fish-processing factories plus the safe breeding site provided by "Bird Rock" guano platform attract large numbers. At the Orange River's mouth *P. onocrotalus* is present (Grindley 1959) whilst at Luderitz it has not been observed during the past 10 years (Dyck 1972, pers. comm.). Beyond these coastal points no counts have been made due to the difficulty of access.

In the Etosha Pan — Lake Oponono area (Figure 1) HHB found that there were at least 6 000 adult birds during September 1971. Winterbottom (1966) did not record White Pelicans in the Kaokoveld and Kunene River, neither did he find them in the Okavango Valley. The only remaining area in the north of SWA where White Pelicans are known to occur in numbers is the Caprivi Strip and here they have been recorded only from lagoons, not rivers (Irwin *et al.* 1969). The Caprivi Strip's most populous area of pelicans (both *P. onocrotalus* and *P. rufescens*)

is Liambezi Lake where the latter species was more common and numerous, with flocks of 50 or more (Irwin *et al.*, *op. cit.*). There is a record of small groups of *P. onocrotalus* from Nyainyai (Naye-naye) Pan in the Tsumkwe area during June 1972 (Jensen, pers. comm.).

At present the species can be described as numerous in a few isolated areas of the northern parts of the Territory as well as along a portion of its Atlantic coastline. Hardap Dam in the central area harbours a few White Pelicans from time to time.

In the absence of more definite information, the total number of White Pelicans in South West Africa is tentatively set at between 7 000 and 10 000, the former figure being the minimum known number. If large scale migration exists between SWA and places in adjacent territories, such as Lake Ngami, it will influence these figures.

IV. DESCRIPTION OF AREA

The great saline pan of Etosha, together with its major contributing watercourses, has been described (Berry 1972). For the purpose of this paper it is essential to include Lake Oponono, situated outside Etosha National Park, 70 km to the north-west of the main pan body (Map 2). The lake forms an integral part of the ecology of the White Pelican in this area. It is served by numerous perennial watercourses and *oshanas* (lakes) to the north. The Kuvelai River is notably important, draining from north to south into Oponono and the Ekuma River in turn flows seasonally from the lake's southern shores, entering Etosha National Park and finally the Pan.

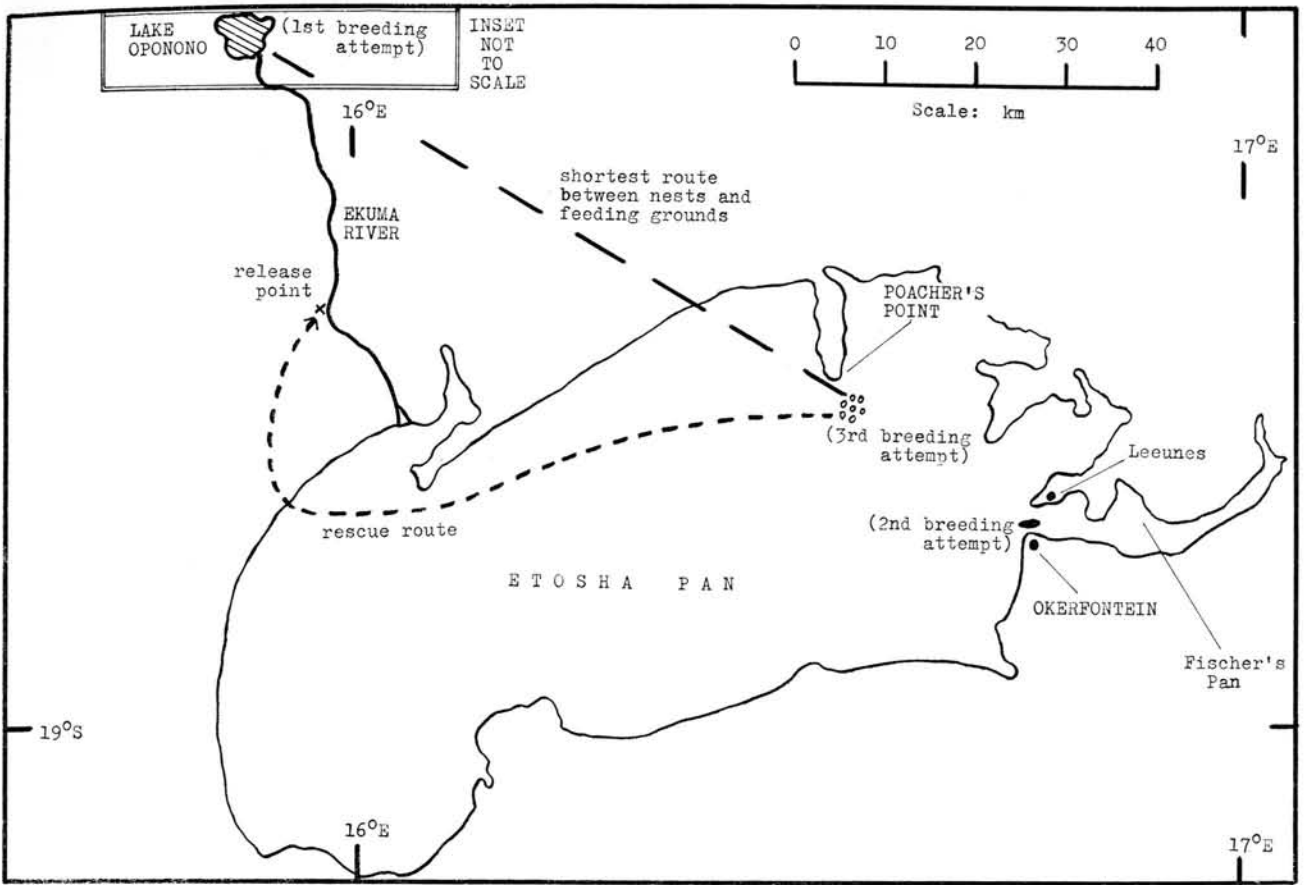
Yearly rainfall, recorded at four stations in the catchment area of Lake Oponono averaged 446 mm over a total recording period of 48 years, (Weather Bureau, Windhoek). The maximum recorded was 766 mm and the minimum 223 mm. Three of these stations are spaced along the banks of the Kuvelai River or its tributaries.

The amount of water held by the Etosha Pan is therefore to a large extent dependent on the flow of the Ekuma River from Lake Oponono. This supplements the seasonal average of 430 mm which precipitates over Etosha National Park (Weather Bureau, Windhoek).

V. OBSERVATIONS

1. Unsuccessful breeding attempts

In 1971 White Pelicans suffered two serious, consecutive setbacks when they attempted to breed in the north of SWA. The incidents took place in areas about 130 km apart and could only be related to one another chronologically once the breeding



Map 2. Etosha Pan showing areas of White Pelican activities.

season was well advanced. On evidence present the following sequence of events must have occurred. A large breeding colony (c. 1500 pairs) was established on a sandy islet in Lake Oponono, Owambo, probably in June (Map 2). About 3000 eggs were laid but before incubation could be completed fishing parties of local tribesmen moved into the area and erected temporary camps along the banks of the lake. They were accompanied by hunting dogs which swam the shallows, gaining access to the nests. This disturbed the breeding birds to the extent that the eggs were totally abandoned. During a survey flight over the lake the dogs were seen on the sand-bars and probably scavenged the abandoned eggs. The tribesmen were possibly also responsible for egg-gathering.

A second attempt to establish a breeding colony was made by the pelicans at the beginning of July. The site selected was 130 km to the south-east of Lake Oponono, on a small island (200 m x 50 m) lying about 0.5 km into the Etosha Pan at Okerfontein (Map 2). The island was separated from the Pan's edge by water only a few centimetres deep. However it created an effective barrier for scavengers by causing the clay foundation of the Pan to become extremely slushy and difficult to cross.

On July 9 a total of about 200 eggs had been laid, mostly two-a-nest, and about 400 adult White Pelicans were present on the island.

During the following week the water surrounding the island dried rapidly and the clay became firmer. By July 19 jackal and hyaena spoor led from the edge of the Pan to the island. The eggs, now numbering 178 plus 105 already broken, were abandoned. No birds were present at the nests. A day prior to this a group of 45 pelicans were observed flying across the Etosha Pan from Okerfontein towards Poacher's Point.

2. Eventual breeding site

The third — and final — breeding attempt of the pelicans was at a site which could hardly be credited to this species. An aerial survey of the Etosha Pan on July 26 showed that many hundreds of White Pelicans had already positioned themselves amongst a colony of flamingo nests, four kilometres south of Poacher's Point (Berry 1972), Figure 2. The flamingoes' breeding cycle may very well have been terminated by the pelicans. Some flamingo nests still held eggs whilst the former occupants had grouped to one side of the colony (Plate 1).

At the time egg-laying commenced only a ring of very shallow water surrounded the nests whilst the remainder of the Etosha Pan was drying out at an ever-increasing rate. The pelican colony was therefore eventually situated on the totally flat and waterless Etosha Pan; in area more than 6000 km².

3. Numbers breeding

The estimated number of breeding adult birds increased from about 600 at the end of July to more than 3 000 by mid-September although these figures proved later to be in error. The total number finally breeding was subsequently re-estimated at c. 6 000 (3 000 pairs). This discrepancy is deserving of an explanation and the reason became apparent later: for as many adult birds as were present at the nests, there were about the same number temporarily absent at the distant fishing grounds.

Very small chicks were first seen on a survey flight on August 20. This confirmed that egg-laying began in mid-July. No numbers could be estimated as the adult birds brooded them very closely and refused to move even when the aircraft flew low. On September 14 an aerial count of young showed that there were about 600 half-grown pulli which had grouped together in clusters typical of the "pods" described by Brown and Urban (1969) when the chicks are entering the "downy feathering stage" (28–42 days). About the same number again of pulli in the "black downy stage" (14–28 days) and a further 300 small pulli in the "naked black stage" (3–14 days) (Brown and Urban 1969) were seen. The majority of chicks of the latter age and younger were undoubtedly still sheltering under their parents (Plates 2, 3 and 4). Based on the number of adults displaying the brooding position (Brown and Urban 1969) the number of very young chicks (less than 14 days) then present is estimated at about 3 200.

4. Nests

The pelicans occupied an area in which approximately 4 500 "grouped" flamingo nests were present (Berry 1972) and appeared to make their own nests at random in between the flamingo nests. It is unlikely that they could have used the flamingo nests. The difference in mass between a Lesser Flamingo *Phoeniconaias minor* (2 kg) and a White Pelican (10 kg) would make it very awkward for the latter species to perch on a relatively tiny nest cup with an inside diameter of 16 cm (Berry *op. cit.*). What did in fact take place was that the pelicans caused the flamingo nests to crumble and eventually flatten into slightly raised mounds.

Egg-laying on these mounds did occur but it was probably coincidental. With no suitable nesting material present the pelicans laid their eggs on the bare, hard clay. In some instances feathers were placed around the eggs.

At Okerfontein the nests were relatively more elaborate than those on the bare Pan. Bits of twigs and some grass and feathers formed a scanty lining.

5. Eggs

The breeding colony of White Pelicans at Poacher's Point commenced egg-laying before the end of July, probably mid-July as was evidenced by the presence

of very small chicks on August 20. This assumes that the incubation period was 5–6 weeks (Brown and Urban 1969). Effective egg-laying probably ceased by mid-August.

When the pelicans abandoned their attempt at breeding on Okerfontein island it presented an opportunity to measure a large sample of eggs. The results are reflected in Figures 1, 2 and 3.

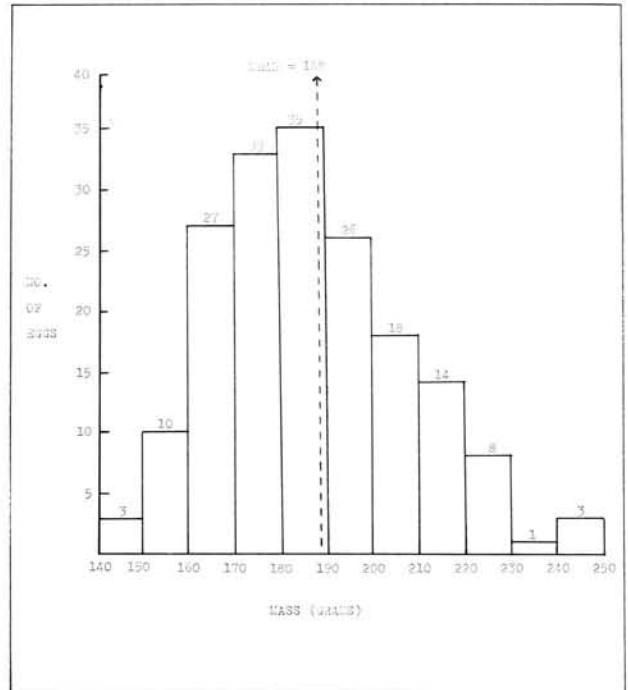


Figure 1. Mass of 178 White Pelican eggs.

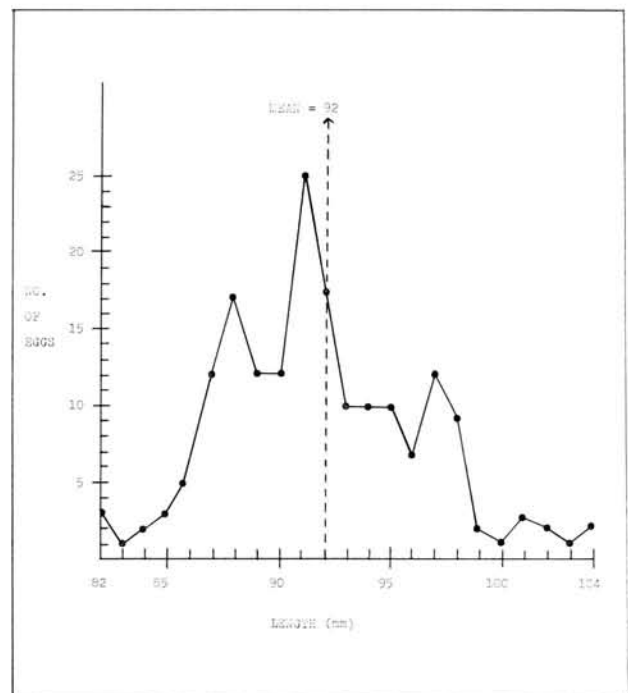


Figure 2. Length of 178 White Pelican eggs.

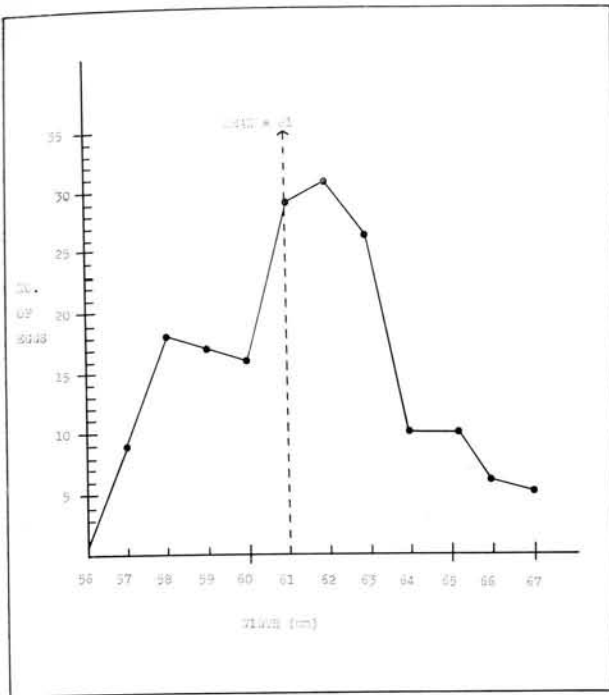


Figure 3. Widths of 178 White Pelican eggs.

Most eggs present were laid in clutches of two. The eggs in a clutch were more similar in width (21 clutches identical) than they were in length (7 clutches identical). In one clutch the two eggs had the same mass (191 g), the same width (63 mm) and differed by 1 mm in length (91–92 mm). The greatest difference within clutches was 4 mm in width and 10 mm in length.

Of the 178 whole eggs remaining at Okerfontein on July 19, 19 were singly laid, 78 nests held 2 eggs and one nest held 3 eggs. A number of eggs were opened and were all found to be in the pre-gastrula phase. The surrounding yolks were rich orange-red. The development phase indicates that the eggs were abandoned early in the cycle and also that laying was synchronised as in the case of flamingo colonies on the Etosha Pan (Berry, *op. cit.*).

6. Observation difficulties

Limited observations on the behaviour of both young and adults during the nesting period were possible. Firstly, the nesting area was only accessible by vehicle in September by which time the young had already hatched. Until then all surveys were carried out by aeroplane. Secondly, and most important, the pelican colony was nesting on an absolutely bare, flat pan which presented no quarter from which to approach undetected. The danger that the birds might again abandon their brood after two earlier disturbances was too great to ignore. Pelicans are notorious for abandoning their eggs (Brown and Urban 1969).

Apart from the rescue attempt of feathered chicks and subsequent observations later in the season, the pelican colony was only once approached at close

range. This was occasioned on September 14 when the aircraft was able to land some distance from the nests and the brooding birds were approached slowly on foot (Plate 5). During this visit the disturbance caused to the colony was sufficient to make us abandon any idea of erecting a hide. A close approach created mass movement of the more mobile chicks away from the nests. Also, the adults' withdrawal to the furthest side of the colony could have disastrous results on the early stage young and the eggs as White Pelicans are clumsy birds on the ground. The best place for observing the colony, albeit at a distance, was from the elevation of Poacher's Point. It is a peninsula which juts out into the Pan for 12 km and the pelican nests were situated 4 km from its southern tip.

7. Behaviour of young

During the fledging period the stages of development as described by Brown and Urban (1969) could be distinguished except for the "naked pink stage" (1–3 days) which would have meant disturbing the adults unnecessarily. The final fledging stage described by Brown and Urban (1969) as the "free-swimming to flying stage" (56–70 days) was, due to circumstances, somewhat different. It should be remembered that from the time the first chicks hatched in mid-August, all surface water had evaporated from that area of the Etosha Pan. The young had therefore never encountered water in their lives and instead of indulging in swimming they would move about at the perimeter of the nests in herds of several hundred.

A few feeds were observed during the close-quarter visit. When adults landed they were immediately singled out by chicks in the downy feathering stage. An adult would lead a single chick to the edge of the colony, whereupon it squatted down and was fairly violently treated by the young bird. The latter immediately thrust its head and fore-body into the open bill of the adult. Its bill must have reached well into the gullet of the parent. Feeds lasted 2–3 minutes.

8. Behaviour of adults

The distinctive brooding attitude adopted by adult birds when the chicks have hatched has been described and illustrated by Brown and Urban (1969). When most adults adopt this attitude it is therefore an indication that incubation by the colony is ending. The majority of pelicans on the Etosha Pan displayed this posture by mid-September.

Although the adults appeared to pay attention to a specific chick during most of the feeds we witnessed, there was an instance when one of us (van Vuuren) saw both adults and feathered young fighting indiscriminately over possession of fish regurgitated onto the ground by a chick. This is somewhat similar to previous observations on *P. onocrotalus* (Stroh 1959 and Dragesco 1961 as cited by Brown and Urban 1969). The latter authors only saw feed-

ing which indicated individual recognition of the chick by its parent.

Chicks in the final fledging stage sometimes wandered away from the nests. In this regard it is noteworthy that the adult birds displayed very definite tendencies to maintain the cohesiveness of the colony and went to great lengths to prevent it from disintegrating. Well-grown chicks would surge away from the nests in a concerted mass, moving without direction on the bare Pan. They would not get far however without a number of adults flying up from the colony and settling in their path. The adults actively curbed the chicks' wandering by blocking their path with threatening bill and wing postures and thereafter shepherded them back to the main colony. These attempts by adults were not always successful and when chicks managed to evade the parental blockade they inevitably met with death far out on the Pan. The majority of mortality was apparently a result of pulli wandering away from the closely-knit breeding colony. This wandering was probably caused by hunger, thirst or a search for shade.

After the attempted rescue of chicks by the Nature Conservation Branch we saw adults curb the scattered chicks in a similar manner. The rescue attempt split the chicks into two main groups about one kilometre apart, with scatterings of chicks in all directions around these groups. Adult birds were seen during the following 24 hours flying back and forth between the chicks, eventually herding them back to the nests in a single group.

9. Voice

Only at close range did the voice of the brooding adults become distinguishable. The only calls heard were a single-syllabled, fairly short "ooo" or "moo". It may have been our intrusion which caused this calling in which case it would be more an alarm note. At a distance of less than a kilometre the adults' voices blended into a soft, continuous, low murmur. Chicks were not heard to call even when extremely agitated, such as when we had several thousand penned in an enclosure prior to a rescue effort.

A full-grown, male White Pelican which was in captivity at Swakopmund, SWA, emitted a single-syllabled, harsh and fairly high-pitched call when being fed. The sound can be described as a screeching "aaar" and lasted one second with frequent repetition. When sound recordings of this call were replayed, persons listening were reminded of the trumpeting of an elephant.

10. Threat displays

No threat displays between adults were seen at the nests and birds brooded peacefully in tight formation. When we caught feathered and final stage chicks during the rescue they would, after realizing their escape was cut off, turn on us with wings half spread and bill held open and pointing. Younger

chicks did not display these tactics and merely attempted to escape.

On the coast of South West Africa HHB has frequently to contend with oil-stained or injured White Pelicans. When these birds are cornered they will almost invariably mount a threat display and very often will press the attack home, their bill clacking quite loudly and wings half extended. An adult male White Pelican in this threatening attitude is a considerable opponent for one person to handle.

11. Food and food source

The pelicans probably commenced carrying fish to the nests by the second half of August (when very small chicks were observed). Adult birds were still seen in fishing formation in the Ekuma River within Etosha National Park's boundaries at this time. Thereafter they shifted their fishing grounds to Lake Oponono as the river's fish population dwindled. By mid-September nearly all the adult pelicans (several thousand) were to be found at Lake Oponono. No other water, bearing fish in sufficient numbers, existed nearer to the nests than this lake.

The pelicans made use of rising air thermals when leaving the nests to fly to Lake Oponono. Brown and Urban (1969) found that use of air thermals by pelicans was a major factor when adult birds nested at Lake Shala, Ethiopia, and fished in other lakes which may have entailed a return flight of hundreds of kilometres. The most direct route between Poacher's Point and Lake Oponono is 100 km and it is likely that the pelicans covered more than this distance as they first had to find suitable air thermals. Each time a fishing trip was undertaken, it would therefore have entailed a return flight of at least 200 km.

The search for a lifting thermal followed a noticeably regular routine. At about 10 h 00 flights of pelicans would take off from the nests, struggling to maintain height in the thin, hot air over the Pan. They almost invariably headed for the peninsula of Poacher's Point where we found it advantageous to position ourselves for observation. Upon reaching the peninsula the birds would "scout" in various directions until a few encountered a favourable thermal. Their constant and heavy wing beats then ceased as they began to glide upwards in a spiral on the lifting thermal. Very soon they became mere dots in the sky and although it is not known what altitude they attained it could have been two thousand metres or higher.

Whilst flying between Etosha Pan and Lake Oponono HHB has found pelicans spiralling at a height of 1 000 m and they have been encountered at 2 700 m over the same area (de la Bat, pers. comm.). The upward-spiralling birds appeared to attract more and more pelicans and long lines or "V" formations of several hundred would head toward the lower part of the spiral. The result was a wheeling vortex of great, white bodies strung out in a slowly turning, rising glide. Wing-beats were made at

irregular intervals as the pelicans sought to remain within the thermal. In this manner they disappeared in a northerly direction, towards Lake Oponono. Their return to the nests probably entailed taking thermals in the vicinity of Lake Oponono because the pelicans descended over Poacher's Point in a long, raking glide.

When chicks in the feathering stage were approached closely in the final stages of the breeding season they disgorged their food, probably an instinct designed to divert the attention of would-be predators to the fish. Another function that this would fulfill is the lightening of the wing-load when the chicks approach fledging. On November 11, freshly-

Table I. Identification of White Pelican chicks' stomach contents.

Fish species	Common name	Length* (cm)	No. present in sample
<i>Schilbe mystus</i>	Silver barbel	10-17	7
<i>Clarias gariepinus</i>	Barbel	22-29	3
<i>Petrocephalus catostoma</i>	Churchill	11	1
<i>Tilapia macrochir</i>	Bream	15	1

* The lengths of the fish in this sample are biased because the containers available could not hold fish longer than 30 cm. It is therefore of interest to note that several fish of larger size were also regurgitated by the pelican chicks. One specimen, a barbel, measured approximately 40 cm.

Table II. Fish netted in the Ekuma River.

Fish species	Common name	Numbers
<i>Schilbe mystus</i>	Silver Barbel	Abundant
<i>Clarias gariepinus</i>	Barbel	Abundant
<i>Barbus paludinosus</i>	Minnow	Abundant
<i>Clarias ngamensis</i>	Barbel	Rare

Table III. Fish caught in the Kuvelai River and immediate vicinity of Lake Oponono.

Fish species	Common name	Numbers
<i>Schilbe mystus</i>	Silver barbel	Uncommon
<i>Clarias gariepinus</i>	Barbel	Abundant
<i>Barbus paludinosus</i>	Minnow	Abundant
<i>Tilapia andersonii</i>	Bream	Rare
<i>Petrocephalus catostoma</i>	Churchill	Rare
<i>Gnathonemus macrolepidotus</i>	Bull-dog	Rare

swallowed, whole fish were collected from the chicks' regurgitations and sent for identification. Table I reflects the results obtained (Bloemhoff 1971, Departmental Report).

A heavy flood in the Ekuma River in April 1971 carried many fish into the Etosha Pan. On April 21 and 22 a section of the Ekuma, lying midway between the Owambo border and the Etosha Pan, was netted for fish over a distance of about 6 km. Table II reflects the fish species caught (Bloemhoff *op. cit.*).

On May 8 an aerial survey of the Etosha Pan showed White Pelicans were fishing in the shallow lagoon formed over about 40 per cent of the Pan's area (Berry 1972). The pelicans were found as far afield from the Ekuma River as Leeunes and Fischer's Pan (Figure 2). An abundant fish supply was present and fish could be easily seen from the aircraft as they churned up the shallow water.

During May a separate survey of fish in the Kuvelai River and streams flowing into Lake Oponono was undertaken. Table III reflects the fish caught (Penrith, pers. comm.).

Comparing Tables I, II and III it is seen that three of the fish species found in the pelican chicks' stomachs also occurred in the Kuvelai River and near Lake Oponono whilst two species occurred in the Ekuma River.

In East Africa, Brown and Urban (1969) observed that the main food of *P. onocrotalus* in Lakes Natron and Nakuru was the Bream *Tilapia grahmi*, whilst in Lakes Rudolf and Rukwa *Tilapia* spp. were also predominant.

1.2. Predators and scavengers

The only mammalian scavenger seen at the pelicans' breeding colony was a single Black-backed Jackal *Canis mesomelas*. It was present on several occasions and did not approach to close quarters. No other mammalian predators were seen and this is curious as the colony lay exposed on dry ground for the entire fledging period. The 12 km-long peninsula of Poacher's Point gave relatively easy access to the colony which lay 4 km away. Lions and other large predators which exist in the area can be considered a potential danger to unfledged pelicans as one of us (HPS) has seen them eat flamingo chicks without hesitation. When rescued pelican chicks were released at the Ekuma River, hyaenas took a number of the live ones.

Avian forms included Lappet-faced Vultures *Torgos tracheliotus* (mostly) and Tawny Eagle *Aquila rapax* (infrequent). When the chicks wandered away from the nests and died on the Pan, up to 12 vultures were to be seen in the area. Near the end of the fledging period (November/December) a pair of Marabou Storks *Leptoptilus crumeniferus* took up position at the nests. None of these birds were observed to kill a healthy youngster. They contented themselves with feeding on carcasses of which a plentiful supply became available.

VI. ATTEMPTED RESCUE OF YOUNG

1. Reasons

Until October the mortality of pulli appeared normal and took place only at the nests. During the first week of that month pulli in the downy feathering stage started wandering in all directions across the Pan. The parental blockade which normally followed such attempts was either ineffective or it did not materialise. The majority headed towards Poacher's Point which is the only object visible from the nests. All the chicks which left the colony died and their carcasses were found scattered as far as the top of Poacher's Point and 10 km out on the Pan. Few adults appeared to follow the chicks once they had left the vicinity of the nests and death was doubtless due to a combination of thirst, starvation and exposure.

During an aerial survey on October 13 a total of about 900 dead pelican chicks were seen away from the nests. We therefore decided to attempt a rescue of some of the remaining chicks the following day. Factors in favour of a rescue were:

- i) the hitherto closely-knit and healthy breeding colony was disintegrating,
- ii) pelicans had never been known to nest on the dry Etosha Pan and the entire breeding effort seemed doomed to failure,
- iii) human interference at the original breeding grounds in Lake Oponono appeared to be the cause of the breeding attempt on the Pan and artificial measures of aid could be justified,
- iv) to our knowledge, no large scale rescue of pelican chicks had been undertaken before and it was necessary to establish the feasibility of such an operation with a view to similar situations in future.

Factors against the rescue being successful were:

- i) it was not known whether the feathering stage chicks, which we intended rescuing, could fend for themselves,
- ii) it would only be possible to transport the chicks to the Ekuma River as Lake Oponono lies outside the boundaries of Etosha National Park. The river's fish supply was presumably less than the lake's at this date and might be insufficient to support the chicks.

2. Method

The following vehicles were used for transporting the chicks:

	Number	Tonnage
	5	1,5
	4	3
	1	5
Totals	10	24,5

The light vehicles were equipped with four-wheel-drive in event of having to extricate the heavier trucks from wet patches on the Pan. The route to the pelicans' nests led from the base camp, Okaukuejo, across the Pan. It totalled 90 km and took two hours.

By 09 h 00 preparations were commenced at the nests. A "V"-shaped holding pen of chicken-wire supported by 2-metre iron standards was erected a few hundred metres from the nests. The standards were driven into the hardened clay surface to a depth of 0,5 m. The height of the pen was 1,5 metre and each of its "arms" extended about 50 m. The loading platforms of the vehicles were enclosed with wire mesh or fish net, the latter being in limited supply. The catching team comprised 10 nature conservators and 25 labourers.

At 10 h 30 preparations were completed and the vehicles and men encircled the nests. The adult birds flew off and settled a short distance away, whilst the mobile chicks were herded into the enclosure (Plate 6). It then became apparent that we had underestimated the numbers present. Several thousand chicks converged onto the closed "V" of the pen and flattened it at various points. A large percentage broke through the circle of capturers and scattered in all directions. To have repeated the encircling would have been pointless and the largest chicks remaining inside the pen were loaded onto the heavy trucks. The light vehicles pursued and caught escaped young which were nearest to fledging. The capture took 1½ hours. In total 1 148 chicks were loaded, after which all vehicles held the maximum number which could be safely transported.

At 12 h 00 the vehicles left for the Ekuma River, reaching the release spot two hours later (Figure 2). The distance travelled was 70 km across the Pan and a further 20 km through the veld. The release point was in the area where fish had been netted earlier in the season (Bloemhoff *op. cit.*).

Tarsal rings of monel metal were placed on 13 chicks which were almost able to fly.

Approximately 10 per cent of the chicks transported died *en route* (108) and 1 040 were released on the river bank. They entered the water without hesitation and swam away.

3. Results

i) Effect on the rescued chicks

To follow up the rescue, one of us (van Vuuren) commenced patrolling the Ekuma's banks on horseback. In the three days following the rescue, 35 dead chicks were found along the Ekuma's banks. About 60 adult pelicans and the same number of young were found 10 km downstream at the river's mouth where it enters the Pan. Here one adult was observed feeding a youngster. The rescued chicks had therefore dispersed over a considerable distance. Groups of them were seen attempting to

fish for themselves. To check on the availability of fish a net was dragged in parts of the river. The catch showed only a few, small fish (5 cm).

The pelican chicks adopted a pattern of activity which suggests that they are sensitive to either strong sunlight or heat. During the hottest part of the day, they nearly all left the water and walked several hundred metres through open grassland to the shade of trees. Gular fluttering was maintained for long periods. After several hours of sheltering from the sun, they returned to the river in the late afternoon, when they immediately attempted to fish. The fact that they relinquished the cool water, which would certainly have lowered their body temperature, and showed preference for shade, indicates that direct sunlight may be the dominant factor. On the other hand it should be remembered that even when cooled on its underbody by water, the darkly-coloured pelican chick will absorb a greater amount of heat than the heat-reflecting white plumage of an adult bird. From this standpoint, heat could be the dominant factor.

The rescue attempt cannot be considered successful because the great majority of chicks at the Ekuma River eventually died. Their carcasses were found in small groups along the river banks. A number were probably also attacked by predators when they rested away from the water. Of the 1 040 chicks released we estimate that not more than 50–100, which were approaching the flying stage, lived. No ringed birds have to date been recovered.

ii) Effect on the remaining nesting colony

HHB stationed himself at Poacher's Point to observe the chicks (c. 3 000) still remaining at the nests.

The adult birds herded most of the young scattered by the rescue back to the nests within 24 hours. About 40 final stage young remained separated, 1 km east of the nests, but adults flew back and forth between them and the colony. On closer approach to the colony, feeds were observed and large numbers of adults commenced taking air thermals towards Lake Oponono by mid-morning of the day following the rescue. The re-grouping of the colony into a compact unit within such a short time is a remarkable achievement when it is considered that the rescue operation caused it to disintegrate over an area of several square kilometres.

On October 19, five days after the rescue, six healthy, feathered young were found near the base of Poacher's Point. They were caught and released near the nests. One of them regurgitated six fairly fresh barbels, weighing a total of 1.3 kg. This indicates that the parent birds must have followed these young after the rescue and, unable to herd them back to the nests, had continued feeding them.

On October 22, it was decided to erect a shelter, under which the chicks could find shade, near the colony. The shelter was supported by standards driven into the clay and was made of a double layer

of hessian held between chicken-wire. It measured approximately 30 m x 4 m and stood 50 m from the nests. The activity involved in its erection caused the adults and young to move away, but its shade value soon became apparent. The pelicans accepted the structure and within two days both adults and young were utilising its shade during the heat of the day. They adopted a pattern of movement similar to the rescued chicks at the river and would return to the nests by late afternoon to spend the night there. Not all the birds could find shade however, because of the limited area of the shelter, but many hundreds made use of it.

VII. GENERAL DISCUSSION

1. Breeding success

By the first week of November, van Vuuren observed that the young at the nests were flying in significant numbers, although a few had been able to fly towards the end of October. Based on HHB's first sighting of very small young on August 20, this would make the total time taken to fledge between 11–12 weeks. Brown and Urban (1969) record a time of 9–10 weeks between hatching and flying. It is possible that the colony we observed took longer due to the dwindling food supply. The mass mortality at one stage supports this theory. The rescue attempt also upset the colony's equilibrium and may have contributed to a longer fledging period.

Mortality amongst the pulli remaining at the nests after the rescue continued and eventually a further c. 1 000 perished.

By November 18, about 1 500 out of 3 000 young were still present at the nests.

At the end of November, 200–300 chicks were still unable to fly. They were in the final stages of fledging.

By the middle of December all young had gone; on the 19th only two adult pelicans were found near some dead young 1.5 km from the nests. In total, we estimate the breeding success as follows:

Chicks hatched	Mortality*	Reason	No. of young fledged
5 000	900	Insufficient food	2 100
	1 000	Attempted rescue	
	1 000	Insufficient food	
Totals: 5 000	2 900		2 100

* Mortality is given in chronological order.

Breeding success was therefore approximately 40% of young hatched and probably less (20–30%) of eggs laid since it is unlikely that all eggs hatched. Brown and Urban (1969) estimate the breeding success of a normal pelican colony to be about 50% of eggs laid. Since the Etosha pelican colony can hardly be described as normal, the decreased breeding success is to be expected.

2. Duration of breeding attempt

Table IV reflects our estimation of the dates and duration of the White Pelicans' breeding attempt on the Etosha Pan in 1971.

The anatomical and colour changes which take place with the onset of the breeding cycle had probably already occurred by the time the pelicans selected Poacher's Point as the site for their third breeding attempt. We saw no definite bulging foreheads ("knobbers") and crests as defined by Brown and Urban (1969). The final stage of breeding plumage (a yellow or brown splotch on the lower neck and breast feathers) was, however, seen on the pelicans and lasted for most of the breeding season.

3. Amount of fish consumed

It has been established that pelican species of similar size to *P. onocrotalus* eat about 11% of their body mass in fish per day (Korodi-Gal as cited by Brown and Urban 1969).

At Swakopmund a captive young White Pelican which was in the feathering stage and had a mass of 6 kg, ate on average 10% of its mass in fish every day (600 g of Pilchards *Sardinops ocellata*, Werthmann, pers. comm.). Six weeks thereafter it had attained a mass of 10 kg and then consumed about 1 kg of fish a day.

Brown and Urban (1969) have calculated that a pair of White Pelicans and their young (2 chicks)

Table IV. Dates and duration of White Pelicans' breeding attempt.

Stage of breeding	Dates From — To	Time taken by colony (weeks)
Display & mating period		?
Nest-building & egg-laying period	mid-July to mid-August	4
Incubation period	mid-July to mid-September	9
Fledging period	mid-August to mid-December	18
Total duration	mid-July to mid-December	22

require about 420 kg of fish to breed successfully (approximately 320 kg eaten by the adults and 100 kg eaten by the chicks). Therefore if the pelican colony on the Etosha Pan which produced young (c. 2 500 breeding pairs) had been completely successful they would have consumed about 1 050 metric tons of fish. From this figure subtract the fish not eaten by the 3 000 chicks which died. Assuming that each chick would have eaten half of its normal intake before it died ($\frac{1}{2} \times 50$ kg) the total mass of fish eaten by the whole colony during the breeding period (22 weeks) will have been 1 050 less ($\frac{1}{2} \times 50$ kg) \times 3 000 chicks = 975 metric tons.

4. Dispersal of young

Very little information exists on this aspect of the White Pelican's post-breeding behaviour in South West Africa. In November a single immature was seen at Klein Namutoni waterhole, Etosha National Park, 45 km south-east of the breeding colony. In December 2 immatures were present at Andoni waterhole, 35 km east of the nests. On December 10, HHB saw 12 immatures in the company of 4 adults on Hardap Dam, 650 km to the south, where the species is not known to breed. These immatures probably originated from the Etosha Pan colony as they were too advanced to have come from the Walvis Bay breeding colony where young only started flying in January.

There is also the possibility that they came from Lake Ngami, Botswana, where hundreds of *P. onocrotalus* with chicks able to swim strongly were seen at the end of July (Dickensen 1972). Banding or marking may provide more data but tarsal rings for pelicans are still being tested in South Africa and the disturbance to a breeding colony caused by banding pulli may not be worth risking.

5. Disturbance and competition by man

At Lake Oponono it has become clear that man and the White Pelican are competing against each other for the same food. The inhabitants of Owambo are improving in material wealth and their transport is becoming more modern. Lake Oponono can now be more easily reached by an extended network of roads. As the human population of Owambo increases, so does its need for protein, which appears in great quantity in Lake Oponono in the form of fish.

This lake is an integral part of the ecology of the White Pelican in the north of South West Africa. If its resources are over-exploited we are confident that White Pelican numbers will decrease considerably in an area which at present probably supports the largest population of this species in South and South West Africa.

It is vital that man's fishing in Lake Oponono be controlled and that the bird-life in the area be pro-

tected. Wild fowl also abound on these waters and are shot, trapped for food or otherwise disturbed in the most delicate part of their territory — the breeding ground.

6. Presence of insecticides in eggs

The occurrence of at least three chlorinated hydrocarbon insecticides, of which DDT is the most prominent, in the eggs of Lesser Flamingo sampled from the Etosha Pan has been established (Gibbs and Pienaar as cited by Berry 1972).

Eggs of *P. onocrotalus*, sampled at Okerfontein island, Etosha National Park, and submitted for analysis, were also found to contain the same insecticides and their metabolites. The average amounts present are:—

DDT	(0,069 ppm)
TDE	(0,206 ppm)
DDE	(0,390 ppm)
dieldrin	(0,100 ppm)
alpha-BHC	(0,010 ppm)
beta-BHC	(0,030 ppm)
gamma-BHC	(0,017 ppm)

(Gibbs and Pienaar 1972)

Lesser Flamingoes feed on algae; White Pelicans feed on fish and the amounts of insecticide isolated in *P. onocrotalus* eggs are, in most cases, 2–5 times as much as the same insecticides found in Lesser Flamingo eggs. This tendency follows the well-known pattern in which insecticides become more concentrated as they pass to higher links in the food chain (Carson 1962).

The increase for the various insecticides and their metabolites in White Pelican eggs compared to Lesser Flamingo eggs is:

Insecticide	Increase
DDT	5 ×
TDE	2 ×
DDE	2 ×
dieldrin	3 ×
alpha-BHC	0
beta-BHC	3 ×
gamma-BHC	0

Specimens of the Brown Pelican *P. occidentalis* taken from Pacific Ocean localities were found to contain 84,4 ppm total DDT residues in the breast muscle (Risebrough *et al.* 1967) and it is noteworthy that this species suffered a population collapse in the late 1950s (60 000 pelicans disappeared from the Gulf Coast of America — McNulty 1971).

The White Pelican of North America *P. erythrorhynchus* has been found to contain an average of 1,7 ppm DDT in all eggs sampled from five colonies and Anderson *et al.* (1969) have demonstrated a significant

ant regression of shell thickness and residues of DDE plus TDE in this species. Decreased egg-shell thickness caused by the chlorinated hydrocarbon insecticides (DDT, BHC, dieldrin) results in egg-breakage and has been widely proved in predatory and fish-eating birds (Lockie and Ratcliffe 1964; Ratcliffe 1967a, 1967b; Hickey and Anderson 1968).

The potential danger of insecticide residues, even in the trace amounts found in the Etosha Pan area, cannot be ignored. Monitoring of eggs should be repeated if pelicans continue to breed in Etosha National Park.

VIII. SUMMARY AND CONCLUSIONS

The White Pelican *Pelecanus onocrotalus* is numerous in two separate, isolated areas of South West Africa and breeds in these parts. Tentative total population estimates for SWA in 1971 are 7 000–10 000. On present evidence the pelican population in the Lake Oponono—Etosha area (c. 6 000) is in greater danger of decreasing than the coastal population at and around Walvis Bay (1 000).

In 1971 *P. onocrotalus* was recorded breeding on the Etosha Pan for the first time after two prior attempts (at Lake Oponono and on the edge of the Pan) had failed. The Pan held no water during the latter half of the breeding period. It is therefore unsuitable as a permanent food source for *P. onocrotalus* yet it affords the species the isolation it requires to produce young successfully. The basic food requirements for the large numbers of pelicans in this area can only be met by Lake Oponono which lies outside Etosha National Park. The lake is being increasingly exploited by man and steps should be taken to protect its abundant avifauna.

The parent pelicans obtained fish from Lake Oponono by using air thermals which enabled them to glide great distances and in this way valuable energy was saved. The minimum return distance between the nesting area and the lake is 200 km. Chicks' stomach contents showed that *Schilbe*, *Clarias*, *Petrocephalus* and *Tilapia* were the main food species. The first 3 species also occurred in the Lake Oponono area. Approximately 975 metric tons of fish were consumed by the pelicans during the breeding cycle.

Based on the number of young hatched (c. 5 000) the number of breeding pairs present was estimated at 3 000. About 2 000 young fledged (40% of young hatched), a further 2 000 died around the nesting area through insufficient food and exposure and 1 000 well-grown chicks which we removed to water also perished. The breeding period lasted 5–6 months (July–December) after which the immatures may have dispersed hundreds of kilometres.

Relatively few predators and scavengers were present at the nesting area.

Eggs of *P. onocrotalus* sampled from the Etosha Pan contain DDT, BHC and dieldrin insecticides.

On present knowledge and experience gained from a rescue of over 1 000 well-grown pelican chicks, we do not recommend that similar attempts be undertaken in future. If the breeding situation repeats itself we would like to see the colony disturbed as little as possible, with aircraft and visits by land used for study purposes only.

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Plate 1. White Pelicans commence nesting on the drying Etosha Pan. Flamingoes, which have been deprived of their nesting area by the pelicans, are grouped behind the nests.

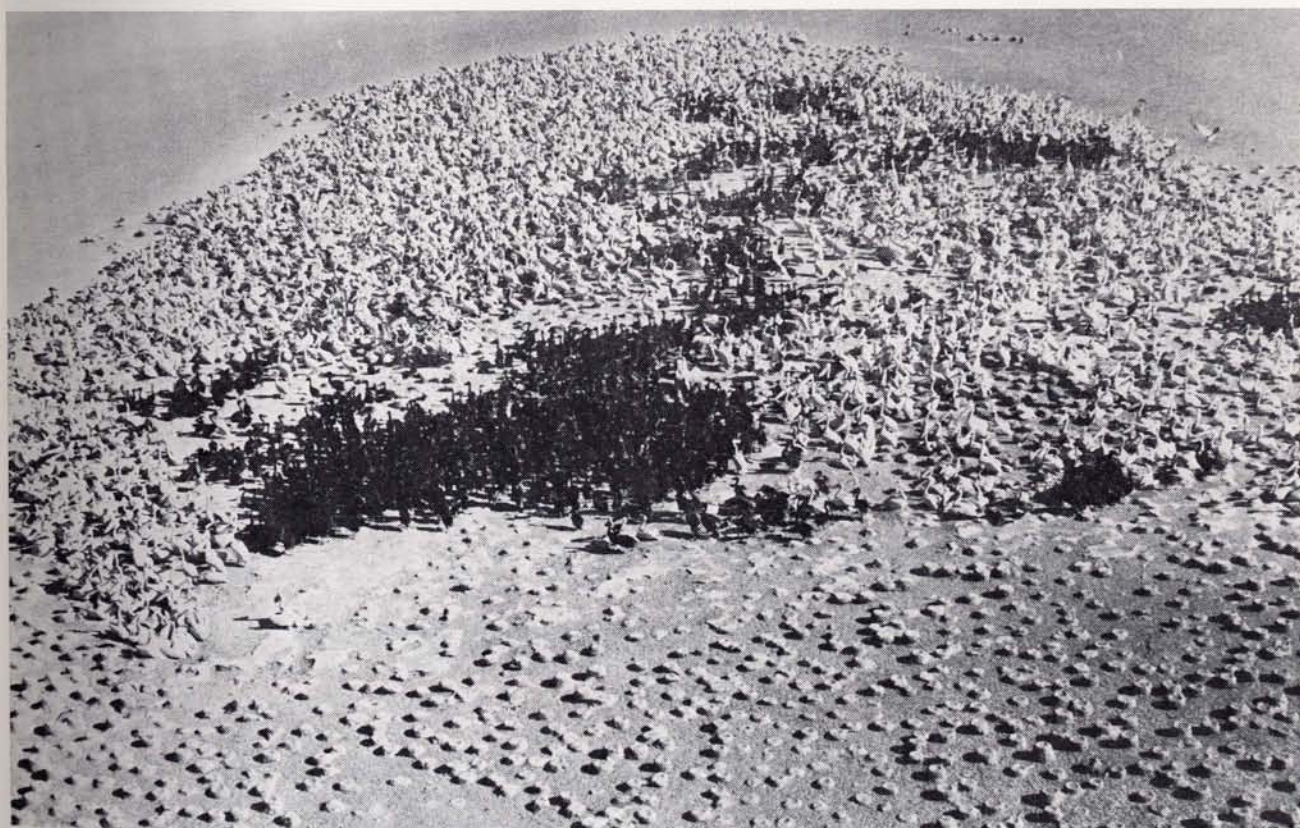


Plate 2. Aerial view of portion of the pelican breeding colony showing the typical clustering of larger chicks. Partly-flattened flamingo nests dot the foreground.



Plate 3. Three naked, black pelican chicks, not yet able to support themselves on their legs.



Plate 4. Brooding adults were tightly massed at the nests. Note the small, black chicks at their feet.



Plate 5. A cluster of pelican chicks in the "downy, feathering" stage. Poacher's Point rises in the background.



Plate 6. Carcasses lie scattered at the colony's edge as the pelican chicks are herded from the nests towards the rescue enclosure