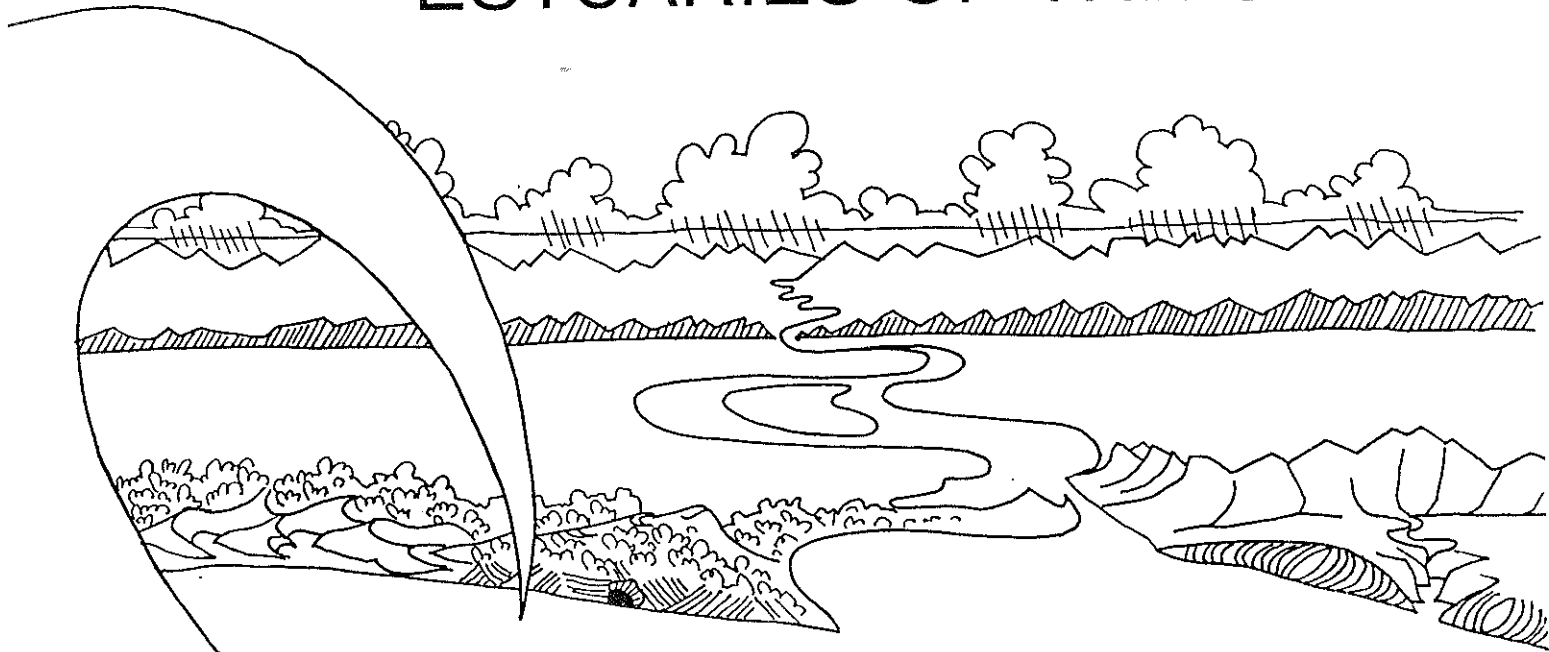


COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
ESTUARINE AND COASTAL RESEARCH UNIT – ECRU



ESTUARIES OF THE CAPE



PART II

SYNOPSIS OF AVAILABLE INFORMATION
ON INDIVIDUAL SYSTEMS

EDITORS: A E F HEYDORN
J R GRINDLEY

REPORT NO. 5

HOLGAT (CW2)

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PREFACE

The Estuarine and Coastal Research Unit (ECRU) was established by the National Research Institute for Oceanology of the CSIR in 1979 with the following aims :

- to contribute information relevant to the development of a cohesive management policy for the South African coastline;
- to compile syntheses of all available knowledge on the 167 estuaries of the Cape between the Kei and the Orange rivers;
- to identify gaps in information and to stimulate research at Universities, Museums and other institutions to fill these.

The Unit was established at the request of the Government, and the Department of Water Affairs, Forestry and Environmental Conservation contributes substantially to the running costs.

In 1980 the Unit published its first report under the title "The Estuaries of the Cape, Part I - Synopsis of the Cape Coast. Natural Features, Dynamics and Utilization" (by Heydorn and Tinley)*. As the name of the report implies, it is an overview of the Cape Coast dealing with aspects such as climate, geology, soils, catchments, run-off, vegetation, oceanography and of course, estuaries. At the specific request of the Government, the report includes preliminary management recommendations.

The present report is one of a series on Cape Estuaries being published under the general title "The Estuaries of the Cape, Part II." In these reports all available information on individual estuaries is summarized and presented in a format similar to that used in a report on Natal estuaries which was published by the Natal Town and Regional Planning Commission in 1978. It was found however, that much information is dated or inadequate and that the compilation of Part II reports is therefore not possible without brief prior surveys by the ECRU. These surveys are usually carried out in collaboration with the Botanical Research Institute and frequently with individual scientists who have special interest in the systems concerned. One of these is Prof J R Grindley of the University of Cape Town who is co-editor of the Part II series.

These surveys are however not adequate to provide complete understanding of the functioning of estuarine systems under the variable conditions prevalent along the South African coastline. The ECRU therefore liaises closely with Universities and other research institutes and encourages them to carry out longer-term research in selected estuarine systems. In this way a far greater range of expertise is involved in the programme and it is hoped that the needs of those responsible for coastal zone management at Local-, Provincial- and Central Government levels can be met within a reasonable period of time.

Finally, it has been attempted to write the Part II reports in language understandable to the layman. However it has been impossible to avoid technical terms altogether. A glossary explaining these is therefore included in each report.



F P Anderson
DIRECTOR

National Research Institute for Oceanology
CSIR

* CSIR Research Report 380

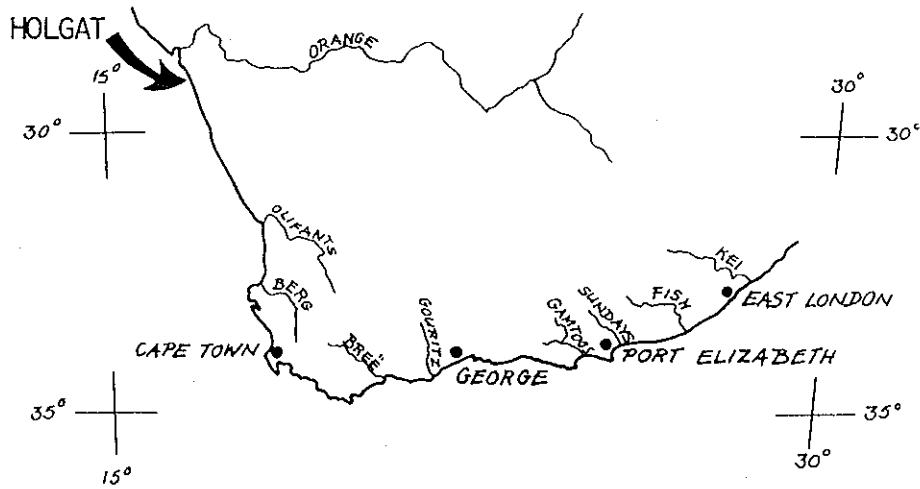
HOLGAT

1. SYNONYMS AND DERIVATIONS

No synonyms recorded.

2. LOCATION

28° 59' S 16° 43' E



The mouth of the Holgat is situated approximately 56 km south-east of the Orange River mouth and 35 km north of Port Nolloth. (1:250 000 Topographical Sheet 2816).

2.1 Accessibility

Accessible by State Alluvial Diggings salt roads running along the coast from Port Nolloth to Alexander Bay. As the coastal strip between Port Nolloth and Alexander Bay is mined for diamonds by State Alluvial Diggings, access to the Holgat Estuary is prohibited for security reasons.

3. ABIOTIC CHARACTERISTICS

3.1 Catchment :

Area

1 500 km² (Heydorn and Tinley 1980).

River length

The total river length from the Stinkfontein Mountains in the catchment, to the mouth of the Holgat is approximately 80 km (1:250 000 Topographical Sheet 2816).

Tributaries

In the upper catchment : The Gaigas River, Klipneus River and Modderfontein se rivier drain the western side of the Stinkfontein Mountains about 60 km inland. (1:250 000 Topographical Sheet 2816).

Mean annual run-off

The Holgat flows only very occasionally with the last flood having been about 50 years ago (A P Burger pers. comm.). According to Keyser (1972) the Holgat last flowed in 1925.

The mean annual rainfall in the upper reaches of the catchment ranges between 100 and 200 mm, whilst in the lower reaches it is less than 100 mm, falling to less than 50 mm at the coast. (Le Roux and Ramsey 1979; Heydorn and Tinley 1980).

3.2 Flow :

Episodic (Heydorn and Tinley 1980).

Flood history and level fluctuations

At the time of the ECRU survey on 14 October 1980, the estuary was dry with indications of past intrusion of sea water (dried kelp) during high tides. The river channel is lined by low broken cliffs (3-10 m high) down to about 3 km from the mouth, indicating substantial cutting action by water.

According to an article in Die Burger of 27 January 1981, the Holgat flooded in March 1961. This would seem to contradict the above report of the Holgat last having flooded 50 years ago, and also appears to be contradicted by undamaged road causeways.

3.3 Obstructions :

(a) In the catchment

A road embankment without any form of culvert, totally blocks the river channel about 2 km from the mouth (Figs. 1 and 2). The same applies to the main road between Port Nolloth and Alexander Bay, 7 km from the coast. At the time of the ECRU survey there was some water in the river bed upstream of the main road between Port Nolloth and Alexander Bay. According to Mr A P Burger of State Alluvial Diggings, the river has not come down in flood since the construction of the main road in 1937. The main road embankment might be broken through in an episodic flood, but it is unlikely that this would cause serious ecological damage.

(b) Near the mouth

The only disturbance in the estuary is the "L" shaped water trench (Figs. 1 and 3) used for the maintenance of roads and processing of diamond gravel. The two arms of the trench were 100 m and 70 m long respectively and the width was about 10 m. Water depth varied from 0,5 to 1 m at the time of the ECRU survey.

3.4 Siltation

There is evidence of alluvial sediments overlain by wind-blown sediments in the riverbed. Layering of sediments can be seen in the cut-away sides of the mining water trench (Fig. 3).

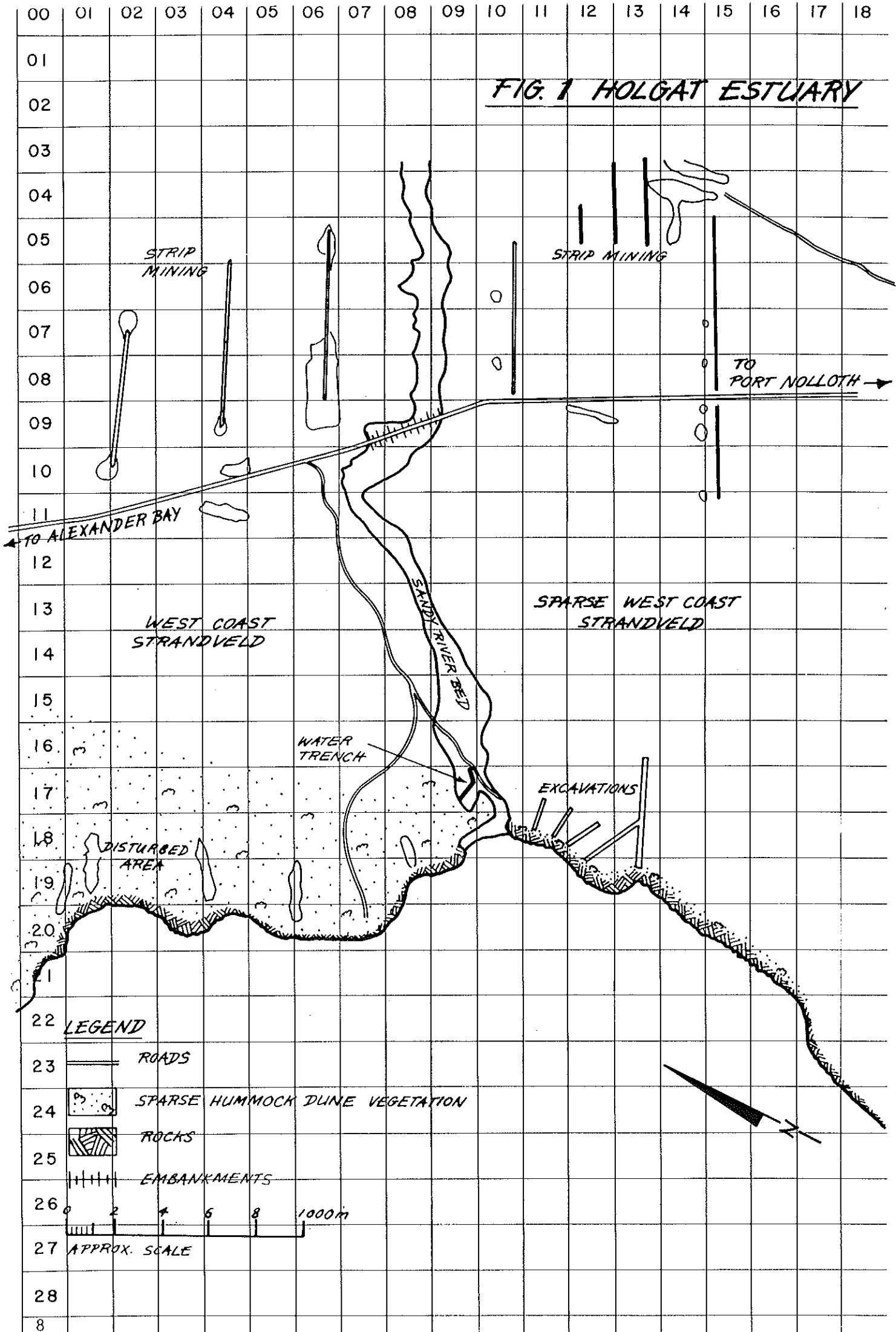




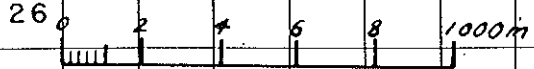


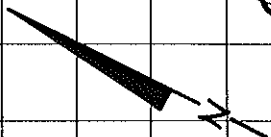
FIG. 1 HOLGAT ESTUARY

LEGEND

- 23  ROADS
- 24  SPARSE HUMMOCK DUNE VEGETATION
- 25  ROCKS
- 26  EMBANKMENTS



APPROX. SCALE



3.5 Landownership / use :

(a) Catchment

State land indicated as "Korridor Wes" on 1:250 000 Topographical Sheet 2816. It is used for extensive sheep farming.

(b) Around the estuary

Diamond Mining by State Alluvial Diggings (Department of Mineral and Energy Affairs).

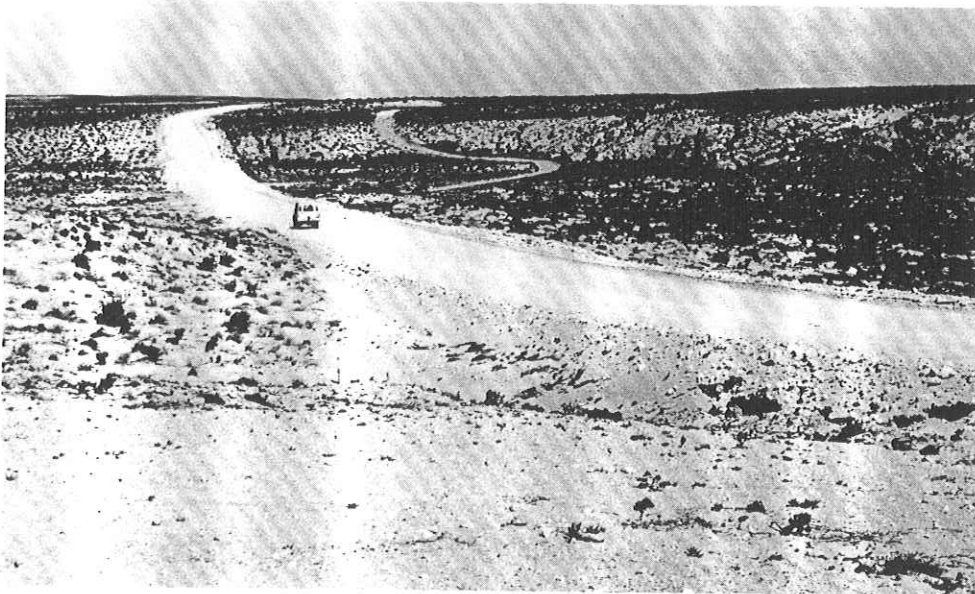


FIG. 2 : State Alluvial Diggings road across the Holgat approximately 2 km upstream of the mouth. The riverbed runs downstream to the right of the photograph. (ECRU 80-10-14)

3.6 Local authority :

State Alluvial Diggings.

3.7 Estuary uses :

Water supply from trenches for diamond mining in the vicinity.

3.8 Morphometry of the Estuary

Area

The Holgat cannot be classified as a true estuary but sea water washes in during exceptionally high spring tides, as indicated by

dried kelp dispersed over the riverbed near the mouth.



FIG. 3 : Eastern arm of excavated water trench in the riverbed at the mouth of the Holgat. The pumping equipment can be seen in the background. (ECRU 80-10-14)

Shape (See Fig. 1)

Almost straight, varying in width from about 10 m to 260 m, although the riverbed is not well defined.

Bathymetry

The estuary is filled with sand to above sea level. The water depth in the trench was 0,5 to 1 m at the time of the ECRU survey.

3.9 Geomorphology :

Geology

(After Coward (1981) unpublished)

The description in the following paragraph is based on that given in Truswell (1977).

The geology of the Holgat is predominated by greywacke¹, grit² and schist³ of the Holgat Formation, which is a part of the Gariep Trough. The Holgat Formation is exposed by the river along its course, extending from the mouth to well inland. North and south of the riverbed are superficial deposits of loose wind-blown sands.

On the shoreline adjacent to the mouth of the Holgat, the underlying rock is exposed. Rogers (1977) describes the bedrock composition as gneissic⁴, arkose⁵ and schist with the rocks on either side of the beach showing evidence of quartz intrusion in straight cracks. Finer straight cracks contain crumbling black material, possibly breccia⁶. These latter features were noted during the ECRU survey.

- ¹ greywacke : strongly cemented, fine to coarse sandstone large angular particles which are mainly rock fragments.
- ² grit : a coarse sandstone with grains of uneven size.
- ³ schist : medium-grained rock affected by regional metamorphism causing a re-crystallization' usually with a foliated, sometimes wavy texture.
- ⁴ gneissic : a term applied to banded rocks formed during high grade regional metamorphism.
- ⁵ arkose : a coarse-grained sandstone or grit containing a high percentage of fragments of feldspar, usually with a siliceous cement.
- ⁶ breccia : a rock composed of angular broken fragments mixed with finer material.

Nature of bottom materials

Rogers (1977) states that "the nearshore zone of littoral drift along the coast of Namaqualand is starved of sediment because its dune-covered arid hinterland readily absorbs the scanty run-off".

At the time of the ECRU survey, there were light-coloured medium coarse marine sediments in the bed of the estuary between the water trench and the sea. In the trench itself, medium-grained sand was overlying black anoxic sediments. These sediments were overlying a schistose (micaceous) bedrock as seen from the surrounding topography.

Sandbar characteristics

During the ECRU survey, the sandbar shelved gently upwards from the beach with a slope of 1:18. There was a wind-blown crest some 1,7 m above MHWS levels.

Configuration of adjacent shore

The mouth of the Holgat opens onto the southern side of a 250 m wide beach. On either side of the beach are rocky promontories which form the central part of a shallow arcuate bay (Fig. 1).

3.10

Oceanography :

Major currents

The Namaqualand coastline is under the influence of the northflowing Benguela Current with characteristic upwelling of cold nutrient-rich water. Upwelling is enhanced during summer, by the prevalence of southerly to south-easterly winds, which tend to move inshore surface water away from the coast, thereby making room for the deeper-lying cooler water (Heydorn and Tinley 1980).

The influence of the Benguela Current, combined with predominantly southerly winds, is largely responsible for the cool climate at the coast and the prevalence of fog during the nights and in the mornings.

Waves

Prevailing swells approach the coast predominantly from a south-westerly or south south-westerly direction. They reach a height of over 1,6 m for 50 percent of the time in the nearshore area, as measured at Oranjemund, 56 km to the north of the Holgat (J. Rossouw pers. comm.). Wave frequency at Buchu Bay, 29 km to the north of the Holgat, is 10-15 seconds for 95 percent of the waves (Ashby, Harper and Van Schaik 1973).

The wave and swell patterns of the West Coast play a major role in the longshore distribution of marine sediments, erosion and deposition phenomena and hence also in beach and dune formation (Tankard and Rogers 1978).

Surf zone currents

During the ECRU survey, there were no pronounced surf zone currents. However, from Aerial Photography Job 326 of 1979, there appear to be rip currents on the northern sides of both the southern and northern rocky promontories on either side of the beach.

Tides

The ECRU survey was carried out over a low tide period midway between neap and spring tides.

Tidal levels in 1980 for Port Nolloth (35 km south of the Holgat mouth) were as follows :

LAT	MLWS	MHWS	HAT
-0,21	0,09	1,66	2,03

This gives a tidal range between MLWS and MHWS of 1,57 m and between LAT and HAT of 2,24 m (South African Tide Tables, 1980).

3.11 Physico-chemical characteristics :

No data are available other than those collected by the ECRU on 14 October, 1980. As the only water in the riverbed near the coast in recent years has been in the water trench (Fig. 3), the data are minimal.

At midday on 14 October 1980, the salinity of the water in the trench (Grid Ref. 1709) was 50 parts per thousand, the water transparency (Secchi) was greater than 1 m (maximum depth) and the surface water temperature was 21,3°C.

3.12 Pollution

No data are available, other than those collected during the ECRU survey, when globules of crude oil were present on the beach and in the sandy bed of the estuary.

There has been extensive disturbance of sediments by mining operations, both in the riverbed and in the catchment area.

3.13 Public health aspects

No data available, but the riverbed has been virtually dry for some years.

4. BIOTIC CHARACTERISTICS

No previous information on the plant and animal life of the estuary could be found. The observations below were made by the ECRU during a brief visit.

4.1 Flora :

Phytoplankton/diatoms

At the time of the ECRU survey, the water in the trench contained blue-green and filamentous algae (Chaetomorpha). Associated with the filamentous algae were many pennate diatoms.

Aquatic vegetation .

There was no evidence of aquatic vegetation in the lower reaches of the riverbed at the time of the ECRU survey.

In the sea, kelp Ecklonia maxima was dominant. Other algae present were Gigartina radula, Aeodes orbitosa, Porphyra capensis and coralline algae.

Semi-aquatic vegetation

Sarcocornia pillansii was present between the water trench and the beach at the time of the ECRU survey (Fig. 4).

Terrestrial vegetation

(Contribution by Miss R Parsons, Botanical Research Institute, and Miss A Le Roux, C.P.A. Department of Nature and Environmental Conservation.)

This area falls into Acocks' Veld Type 34 (b) Strandveld Proper, which has many variations and can best be described here as an open, semi-succulent scrub (Acocks 1975).

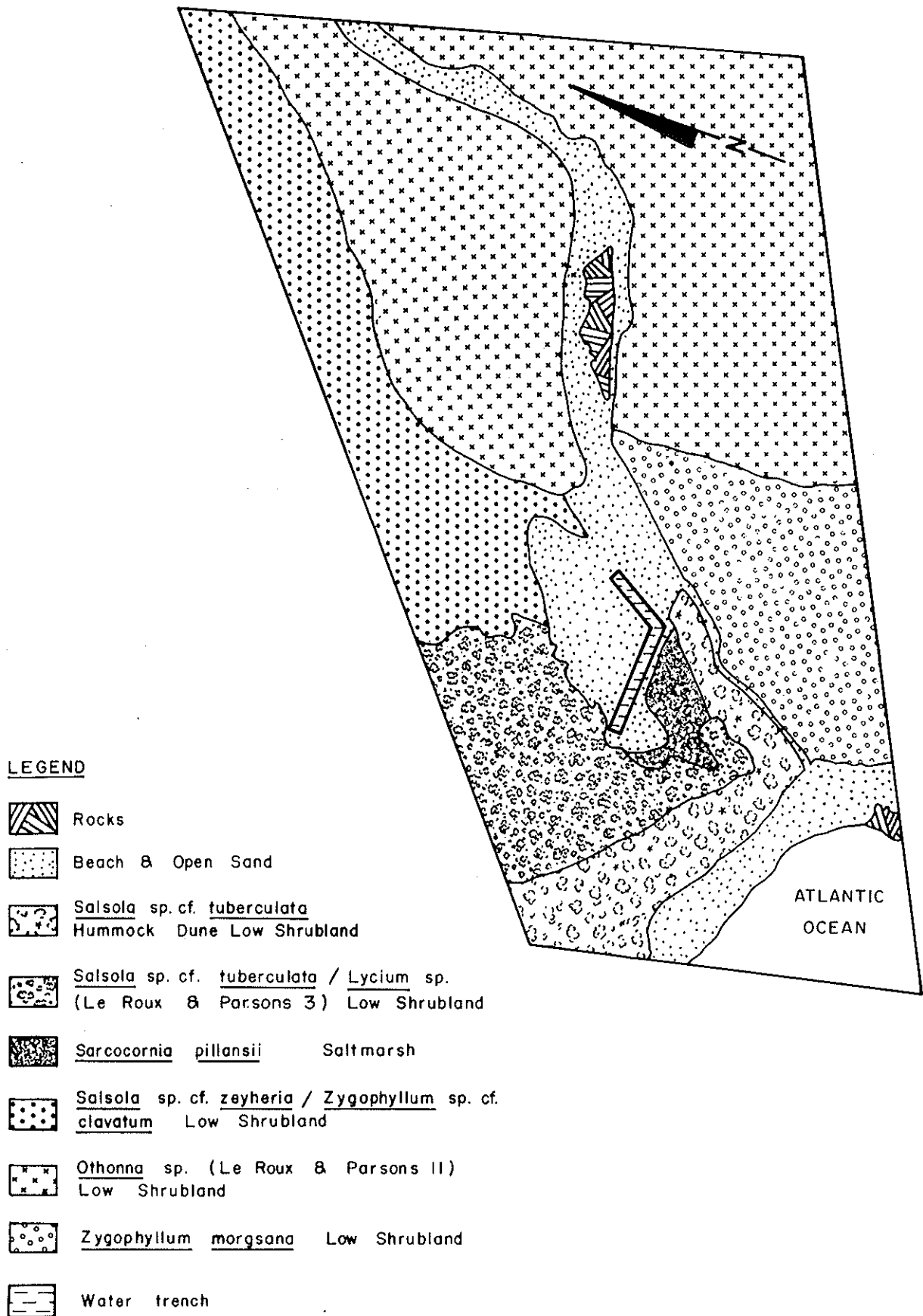
Six main vegetation mapping units were identified and their structure, species composition and area are shown in Appendix I and their spatial distribution in Fig. 4. All the vegetation was low, with a maximum height of 1,0 m and an average height of 0,5 m. Another common feature throughout is the leaf succulence, an adaptation frequently found in arid environments. The Sarcocornia pillansii Saltmarsh has the highest cover (80 %) and the lowest species diversity (1 species). The Salsola sp. cf. zeyheri / Zygophyllum sp. cf. tuberculata / Lycium sp. (Le Roux and Parsons 3)¹ Low Shrubland has the highest species diversity with 9 species recorded.

The vegetation of the areas studied is similar and the six vegetation mapping units can be consolidated into two main plant formations viz. saltmarsh and low shrubland (0,25 - 1,0 m). The low shrubland is the most extensive, covering an area of about 28 ha² and the saltmarsh an area of about 0,4 ha, out of the total of 34 ha studied.

¹Le Roux and Parsons species numbers e.g. Le Roux and Parsons 3, refer to specimens unidentified by the B.R.I. at the time of writing.

²As the accuracy of measurement of the botanical areas given in this section and Appendix I was estimated to be approximately within 5 percent, decimals are given only where they are greater than 5 percent of the area in question.

FIG. 4 : Vegetation mapping units of the Holgat Estuary
 Approximate scale — 1: 5 000



The large barren patch surrounding the trench has a crust (possibly saline) which might explain the absence of any vegetation. A large area of the water in the trench was covered by the green filamentous alga Chaetomorpha.

4.2 Fauna :

Note : Only cursory observations were possible during the ECRU survey and the following lists will be incomplete.

Zooplankton :

At the time of the ECRU survey, plankton sampling in the trench revealed the presence of large numbers of harpacticoid copepods, of which nearly half were in an ovigerous condition. Small white nematodes and chironomid larvae were also present.

Fauna on

(a) hard substrates

The following intertidal animals were found to be abundant on the rocks on the adjacent shoreline.

Cape Reef Worm	-	<u>Gunnarea capensis</u>
Rock Lobster	-	<u>Jasus lalandii</u>
Ribbed Mussel	-	<u>Aulacomya ater</u>
Black Mussel	-	<u>Choromytilus meridionalis</u>
Limpets	-	<u>Patella granitina</u>
	-	<u>P. granularis</u>
	-	<u>P. argenvillei</u>
Periwinkle	-	<u>Littorina sp.</u>
Snail	-	<u>Oxysteles variegata</u>
Whelk	-	<u>Argobuccinum argus</u>

(b) soft substrates

No information.

(c) vegetation

No information.

Insects

Large numbers of kelp flies (Family : Anthomyiidae) were present at the mouth during the ECRU survey.

Other invertebrates

Dried shells of terrestrial snails and millipedes were seen around the mouth of the Holgat during the ECRU survey.

Fish

Typical littoral and estuarine associated species for the region are :

White Steenbras	<u>Lithognathus lithognathus</u>
Galjoen	<u>Coracinus capensis</u>
Hottentot	<u>Pachymetopon blochii</u>
Kabeljou	<u>Argyrosomus hololepidotus</u>
Mullet	<u>Mugil cephalus</u>
	<u>Liza richardsoni</u>

In the past, mullet have been introduced into water trenches, excavated for diamond mining purposes, and have grown to exceptional sizes (A P Burger pers. comm.).

Reptiles and Amphibians

At Muisvlakte on the main road between Port Nolloth and Alexander Bay, a Cross marked Grass Snake (Psammophis crucifer) was seen during the ECRU survey.

Birds

Courtenay-Latimer(1963) recorded the following species in the vicinity of the Holgat mouth during July and August 1958 and August 1960 :

<u>Roberts No.</u>	<u>Species</u>
79	Black Stork
129	Yellow-billed Kite
152	Jackal Buzzard
231	Black Oystercatcher
466	Clapper Lark
506	Rock Martin
619	Rufous-eared Warbler
744	Pale-winged Starling
873	Cape Bunting

The following bird species were recorded for the Holgat Mouth on 14 January 1980. (J Cooper, Percy Fitzpatrick Institute of Ornithology, in litt.)

<u>Roberts No.</u>	<u>Species</u>	<u>No. seen</u>
238	Three-banded Sandplover	1
251	Curlew Sandpiper	1
253	Little Stint	3

During the ECRU survey, the following species were noted :

Beach

<u>Roberts No.</u>	<u>Species</u>	<u>No. seen</u>
47	White-breasted Cormorant	2
54	Grey Heron	4
235	White-fronted Sandplover	7
255	Sanderling	8
287	Southern Black-backed Gull	4
686	Cape Wagtail	1

Estuary

<u>Roberts No.</u>	<u>Species</u>	<u>No. seen</u>
238	Three-banded Sandplover	2
310	Double-banded Sandgrouse	2
488	Red-capped Lark	2
570	Familiar Chat	5
873	Cape Bunting	1

Mammals

At the time of the ECRU survey, the tracks of a felid (probably the African Wild Cat, Felis libyca) as well as steenbok (Raphicerus campestris), were noted at the mouth of the estuary. Surface tunnels indicated the occurrence of a mole or a mole rat species.

Black-backed Jackal (Canis mesomelas) are present in the vicinity of the Holgat as noted when a lactating female was killed by a shepherd at the time of the ECRU survey.

The records of Stuart et al (1980) indicate that the Cape Fur Seal (Arctocephalus pusillus) and the Black-backed Jackal (C. mesomelas) have been recorded in the vicinity of the mouth of the Holgat.

5. SYNTHESIS

Knowledge of the Holgat is extremely limited and historical information is lacking.

The Holgat is not an estuary in the true sense, due to a combination of factors. Although the catchment has an area of 1 500 km² (Heydorn and Tinley 1980), the Holgat last flowed in 1925 (Keyser 1972). The main reason for this appears to be (a) the low rainfall in the catchment (less than 200 mm per annum) and (b) the dune-covered arid hinterland readily absorbs the scanty run-off (Rogers 1977). The high salinity (50 parts per thousand during the ECRU survey) of the water in the trench at the mouth suggests that there is very little subsurface freshwater seepage from higher-lying areas.

Sea water probably only overtops the sandbar during exceptionally high tides combined with heavy swells and strong onshore winds. The absence of run-off over the years has allowed the build up of marine and wind-blown sediments to form a substantial barrier.

Being almost permanently dry (with the exception of the artificially created water trench), the Holgat has minimal value as an estuary. This is borne out by the small numbers of estuarine associated bird species recorded there. Of these, the Three-banded Sandplover could be considered to be estuarine. The Holgat may however be a short-term habitat for water birds after an episodic flood, in an otherwise inhospitable environment.

The morphology of the system indicates that the Holgat has flowed into the sea in the past. Today, the road embankments probably impede the already reduced run-off. However, an exceptional flood would probably break through the road embankments. Although the river has not flowed since the construction of these blockages, some facility for the free passage of water should be made.

6. ACKNOWLEDGEMENTS

The collection of field data for this report was essentially a team effort and the assistance of the other members of the ECRU survey team is acknowledged. State Alluvial Diggings granted permission for the survey to be carried out in areas under their jurisdiction and Mr A P Burger, the Chief Security Officer kindly supplied much local information and acted as guide during the survey.

Thanks are due to Dr A J Prins of the S.A. Museum for identifying the kelp flies and also to Mr J Cooper of the Percy Fitzpatrick Institute, who supplied unpublished bird census data.

The report cover is based on one designed by Dr K L Tinley for Part I of the Cape Estuaries Series. Thanks are also due to the girls of the NRIO drawing office for the preparation of the maps, Mrs S Armbruster for typing this report and Mrs H Heydorn for literature reviews and proof-reading.

The survey was carried out at the request and with the financial support of the Department of Water Affairs, Forestry and Environmental Conservation. The encouragement of this Department, the Cape Estuaries Steering Committee and the S.A. National Committee for Oceanographic Research is gratefully acknowledged.

GLOSSARY OF TERMS USED IN PART II REPORTS

- abiotic: non-living (characteristics).
- aeolian (deposits): materials transported and laid down on the earth's surface by wind.
- alien: plants or animals introduced from one environment to another, where they had not occurred previously.
- alluvium: unconsolidated fragmental material laid down by a river or stream as a cone or fan, in its bed, on its floodplain and in lakes or estuaries, usually comprised of silt, sand or gravel.
- anaerobic: lacking or devoid of oxygen.
- anoxic: the condition of not having enough oxygen.
- aquatic: growing or living in or upon water.
- arcuate: curved symmetrically like a bow.
- barchanoid (dune): crescent-shaped and moving forward continually, the horns of the crescent pointing downwind.
- bathymetry: measurement of depth of a water body.
- benthic: bottom-living.
- berm: a natural or artificially constructed narrow terrace, shelf or ledge of sediment.
- bimodal: having two peaks.
- biogenic: originating from living organisms.
- biomass: a quantitative estimation of the total weight of living material found in a particular area or volume.
- biome: major ecological regions (life zones) identified by the type of vegetation in a landscape.
- biotic: living (characteristics).
- breaching: making a gap or breaking through (a sandbar).
- calcareous: containing an appreciable proportion of calcium carbonate.
- calcrete: a sedimentary deposit derived from coarse fragments of other rocks cemented by calcium carbonate.
- Chart Datum: This is the datum of soundings on the latest edition of the largest scale navigational chart of the area. It is -0,900 m relative to land levelling datum which is commonly called Mean Sea Level by most land surveyors.
- coliforms: members of a particularly large, widespread group of bacteria normally present in the gastro-intestinal tract.
- community: a well defined assemblage of plants and/or animals clearly distinguishable from other such assemblages.
- conglomerate: a rock composed of rounded, waterworn pebbles 'cemented' in a matrix of calcium carbonate, silica or iron oxide.
- cusp: a sand spit or beach ridge usually at right angles to the beach formed by sets of constructive waves.
- "D" net: a small net attached to a "D" shaped frame riding on skids and pulled along the bottom of the estuary, used for sampling animals on or near the bottom.
- detritus: organic debris from decomposing plants and animals.
- diatoms: a class of algae with distinct (brown) pigments and siliceous cell walls. They are important components of phytoplankton.
- dynamic: relating to ongoing and natural change.
- ecology: the study of the structure and functions of ecosystems, particularly the dynamic co-evolutionary relationships of organisms, communities and habitats.
- ecosystem: an interacting and interdependent natural system of organisms, biotic communities and their habitats.
- eddies: a movement of a fluid substance, particularly air or water, within a larger body of that substance.
- endemic: confined to and evolved under the unique conditions of a particular region or site and found nowhere else in the world.
- enon: most striking formation in the Cape. Crammed with pebbles and boulders, phenomenally embedded and massive, yellow or brilliantly red in colour, producing remarkable hills. Curiously carved into crags and hollows.

epifauna: animal life found on the surface of any substrate such as plants, rocks or even other animals.

epiphyte: a plant living on the surface of another plant without deriving water or nourishment from it.

episodic: sporadic and tending to be extreme.

estuary: a partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with fresh water derived from land drainage (Day 1981).

eutrophication: the process by which a body of water is greatly enriched by the natural or artificial addition of nutrients. This may result in both beneficial (increased productivity) and adverse effects (smothering by dominant plant types).

flocculation (as used in these reports): the settlement or coagulation of river borne silt particles when they come in contact with sea water.

fluvial (deposits): originating from rivers.

food web: a chain of organisms through which energy is transferred. Each "link" in a chain feeds on and obtains energy from the preceding one.

fynbos: literally fine-leaved heath-shrub. Heathlands of the south and south-western Cape of Africa.

geomorphology: the study of land form or topography.

gill net: a vertically placed net left in the water into which fish swim and become enmeshed, usually behind the gills.

habitat: area or natural environment in which the requirements of a specific animal or plant are met.

halophytes: plants which can tolerate salty conditions.

HAT (Highest Astronomical Tide) and LAT (Lowest Astronomical Tide): HAT and LAT are the highest and lowest levels respectively, which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions; these levels will not be reached every year. HAT and LAT are not the extreme levels which can be reached, as storm surges may cause considerably higher and lower levels to occur (South African Tide Tables 1980).

hummock (dune): a low rounded hillock or mound of sand.

hydrography: the description, surveying and charting of oceans, seas and coastlines together with the study of water masses (flow, floods, tides etc.).

hydrology: the study of water, including its physical characteristics, distribution and movement.

indigenous: belonging to the locality; not imported.

intertidal: generally the area which is inundated during high tides and exposed during low tides.

isohyets: lines on maps connecting points having equal amounts of rainfall.

isotherms: lines on maps joining places having the same temperature at a particular instant, or having the same average, extremes or ranges of temperature over a certain period.

lagoon: an expanse of sheltered, tranquil water. (Thus Langebaan lagoon is a sheltered arm of the sea with a normal marine salinity; Knysna lagoon is an expanded part of a normal estuary and Hermanus lagoon is a temporarily closed estuary (Day 1981)).

limpid: clear or transparent.

littoral: applied generally to the seashore. Used more specifically it is the zone between high- and low-water marks.

longshore drift: a drift of material along a beach as a result of waves breaking at an angle.

macrophyte: any large plant as opposed to small ones. Aquatic macrophytes may float at the surface or be submerged and/or rooted on the bottom.

marls: crumbly mixture of clay, sand and limestone, usually with shell fragments.

matrix: medium in which a structure is embedded.

meiofauna: microscopic or semi-microscopic animals that inhabit sediments but live quite independently of the macrofauna, or benthos.

metamorphic: changes brought about in rocks within the earth's crust by the agencies of heat, pressure and chemically active substances.

MHWS (Mean High Water Springs) and MLWS (Mean Low Water Springs): the height of MHWS is the average, throughout a year when the average maximum declination of the moon is 23°, of the height of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is greatest. The height of MLWS is the average height obtained by the two successive low waters during the same periods (South African Tide Tables 1980).

morphometry: physical dimensions such as shape, depth, width, length etc.

osmoregulation: the regulation in animals of the osmotic pressure in the body by controlling the amount of water and/or salts in the body.

pathogenic: disease producing.

photosynthesis: the synthesis of carbohydrates in green plants from carbon dioxide and water, using sunlight energy.

phytoplankton: plant components of plankton.

piscivorous: fish-eating.

plankton: microscopic animals and plants which float or drift passively in the water.

quartzite: rock composed almost entirely of quartz re-cemented by silicon. Quartzite is hard, resistant and impermeable.

riparian: Adjacent to or living on the banks of rivers, streams or lakes.

rip current: the return flow of water which has been piled up on the shore by waves, especially when they break obliquely across a longshore current.

salinity: the proportion of salts in pure water, in parts per thousand by mass. The mean figure for the sea is 34,5 parts per thousand, written 34,5‰.

secchi disc: a simple instrument used to measure the transparency of water.

sheet flow: water flowing in thin continuous sheets rather than concentrated into individual channels.

slipface: the sheltered leeward side of a sand-dune, steeper than the windward side.

teleost: modern day bony fishes (as distinct from cartilagenous fishes).

trophic level: a division of a food chain defined by the method of obtaining food either as primary producers, or as primary, secondary or tertiary consumers.

trough: a crescent shaped section of beach between two cusps.

wetlands: areas that are inundated or saturated by surface or ground water frequently enough to support vegetation adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

zooplankton: animal components of plankton.

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- SOUTH AFRICA 1:250 000 Topographical Sheet 2816 Alexander Bay. 2nd edition. Pretoria. Government Printer 1974.
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Aerial Photography

{HOLGAT RIVER} Bl. & Wh. Job No. 122/37. Photo No. 52656.
Trig. Survey, Mowbray. 1:25 000, 1937.

{HOLGAT RIVER} Bl. & Wh. Job No. 525. Photo No. 2767. Trig.
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{HOLGAT RIVER} Bl. & Wh. Job No. 763. Photo Nos. 7425, 7426
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{HOLGAT RIVER} Colour. Job No. 326. Photo Nos. 104/4, 105/4.
Dept. of Land Surveying, Univ. of Natal. 1:10 000, 1979.

{HOLGAT RIVER} Bl. & Wh. Job No. 348. Photo No. 74.
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Species	Hummock Dune Low Shrubland	Salsola sp. cf. tuberculata	Salsola sp. cf. tuberculata/ Lycium sp. (Le Roux & Parsons 3)	Low Shrubland	Othonna sp. (Le Roux & Parsons 11)	Low Shrubland	Zygochloa morgasana	Low Shrubland	Salsola sp. cf. zeyheri/ Zygochloa	sp. cf. clavatum Low Shrubland	Sarcocornia pillansii	Saltmarsh	Beach and Open Sand	Rocks	Trench	Total	
Total cover (%)	15	38	10	5	3	80											
Height (m)	0-1,0	0-0,5	0-0,5	0-0,5	0-0,3	0-0,2											
Area (ha)	2,3	3	14	4	5	0,4											
Z of Studied Area	6,8	8,8	41,2	11,8	14,7	1,2											
Salsola sp. cf. tuberculata	*																
Lycium sp. (Le Roux & Parsons 3)	*																
Drosera sp. (Le Roux & Parsons 4)			*														
Tetragonia fruticosa																	
Psilocaulon sp. (Le Roux & Parsons 6)																	
Othonna floribunda																	
Hypertelis angrae-pequeanae																	
Eragrostis cyperoides																	
Lampranthus sp. (Le Roux & Parsons 29)			*														
Othonna sp. (Le Roux & Parsons 11)			*														
Galenia fruticosa			*														
Othonna sedifolia			*														
Zygochloa cordifolium			*														
Pteronia glabrata			*														
Grielum grandiflorum			*														
Ruschia sp. (Le Roux & Parsons 16)			*														
Lampranthus sp. (Le Roux & Parsons 17)			*														
Zygochloa morgasana			*														
Salsola sp. cf. zeyheri			*														
Zygochloa sp. cf. clavatum			*														
Sarcocornia pillansii																	*

APPENDIX I

Species composition and physical features of the vegetation mapping units of the Holgat Estuary.

APPENDIX II Overleaf

