# FOOD AND STATUS OF THE CAPE CLAWLESS OTTER, *AONYX CAPENSIS* SCHINZ, IN THE TSITSIKAMA COASTAL NATIONAL PARK

by

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To Dolly, Johan and Chris

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ABSTRACT

Food of the Cape clawless otter was estimated from faeces analysis. This was compared with apparent availability estimated from selected sampling in the littoral zone.

An apparent selection of red rock crabs, octopuses and sucker fish, in that order of importance, occurred, while the most common intertidal fishes, the Clinidae, were strongly selected against. The above-mentioned three positively selected species, together with brown rock crabs, caught mainly in the *Littorina* zone, made up about 80% of the diet of otters. Seasonal variation in importance was limited. Mainly larger individuals of the principal prey species were taken.

Holts were counted along the whole coast of the National Park, and activity at some of them was analysed. Together with other data, this led to an estimate of population size of about one otter per 2 km of coastline. This density was ascribed to an ample supply of food, fresh water and shelter.

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VOEDSEL EN STATUS VAN DIE GROOTOTTER, *AONYX CAPENSIS* SCHINZ, IN DIE TSITSIKAMASEEKUS NASIONALE PARK

## SAMEVATTING

Voedselinname en -samestelling van die groototter is deur middel van misontleding bepaal. Die resultate is met skynbare beskikbaarheid vergelyk, wat weer geskat is uit die versameling in geselekteerde gebiede in die littoraalsone.

'n Skynbare selektering van rooirotskrappe, seekatte en suiervisse, in daardie volgorde van belangrikheid, het voorgekom, terwyl die volopste visse in die tussengetysone, die Clinidae, beduidend negatief geselekteer is. Die bogenoemde drie positief geselekteerde soorte het tesame met bruinrotskrappe, wat hoofsaaklik in die *Littorina*-sone gevang is, ongeveer 80% van die dieet van otters uitgemaak. Seisoenale variasie in belangrikheid was beperk. Groter individue van die belangrikste prooidiere is hoofsaaklik geselekteer.

Alle skuilplekke langs die kus is getel, terwyl 'n studie van aktiwiteit by sommige van hulle gedoen is. Tesame met ander inligting het hierdie resultate gelei tot 'n skatting van bevolkingsgrootte van ongeveer een otter per 2 km kuslyn. Hierdie redelik hoë digtheid is aan volop voedsel, vars water en skuiling toegeskryf.

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# INTRODUCTION

In the northern hemisphere otters have been well known for more than a century (Harris 1968). In Canada and North America, Lutra canadensis was, and still is, an important furbearer. Lutra lutra, the European species, although also a furbearer, was in England perhaps better known for its ability to excite man and dog in the popular English pastime, otter hunting (Williamson 1932). In Europe itself it was probably less well-known, although fishermen definitely knew about the destruction of fish and nets for which otters were sometimes responsible (Van Wijngaarden and Van de Peppel 1970, Röben 1974). The competition of American otters with anglers has also been responsible for a negative attitude of American anglers towards these animals. It was largely this aspect which created early active interest in the food of otters on that continent (Ryder 1955, Sheldon and Toll 1964, Toweil 1974 and others.)

Especially in England, grave concern has recently been expressed about the declining otter populations all over the world (Davis 1971, MacDonald, Mason and Coghill 1978). A special Trust* has been initiated with the purpose of breeding otters and promoting research on them. Much of the decline has been due to excessive hunting, but the disappearance of suitable habitat has apparently been at least as important (MacDonald et al. 1978).

The scarcity of Lutra lutra in England has given rise to a recent spate of research (Hewson 1973, MacDonald et al. 1978 and others). Unfortunately numbers are so low that research becomes extremely difficult.

The history of the sea otter Enhydra lutris has been well documented (Barton 1968, Kenyon 1971, Estes, Smith and Palmisano 1978). Extreme hunting pressure forced numbers down nearly to a point of no return. Concern was expressed, hunting was banned and numbers increased dramatically, so that at present numbers are probably very near the original level (Estes et al. 1978). In this relatively simple case only one factor, hunting pressure, was involved. Such a spectacular rise in numbers is most unlikely to occur in England, where other factors are also involved.

* The Otter Trust, Earsham, nr Bungay, Suffolk, U.K.

Although several other species of otter exist around the rest of the world, apparently very little is known about them. General notes are to be found in popular accounts (Maxwell 1960, Duplaix-Hall 1972), while Duplaix (1977) is studying the Brazilian otter *Pteronura braziliensis*.

Two genera and three species of otter occur in Africa south of the Sahara; *Aonyx capensis*, *A. congica* and *Lutra maculicollis*. The state of knowledge of these species is about the same as that of other otters of the world except *Lutra lutra* and *L. canadensis*. Two popular accounts on *Lutra maculicollis* could be found (Mortimer 1963, Procter 1963). Apart from a few still more popular accounts on *Aonyx capensis* (Carter 1956, Eyre 1963) and general notes (Fitzsimmons 1919, Shortridge 1934, Dorst and Dandelot 1970), Rowe-Rowe (1977 a,b,c) published accounts on the feeding habits of these species in the Natal Drakensberg.

The occurrence of freshwater species of otters in the sea has been noted by early authors such as Fitzsimmons (1919) in South Africa and Elmhirst (1938) in Scotland. It remained a relatively unknown phenomenon, however, until a sudden interest in these otters flared up in the seventies, mainly in England, but also in America (Northcott and Slade 1976, Kruuk and Hewson 1978, Watson 1978, Jenkins, Walker and McCowan 1979). From these studies it became evident that at least *Lutra lutra* was apparently very successful in the sea, but only along suitable rocky coasts. It has even been suggested that the coast is an optimum habitat for otters (Watson 1978).

The only report that could be found on African otters venturing into the sea was that of Tayler (1970), who observed *Aonyx capensis* along the coast near Port Elizabeth. Although not published, however, the occurrence of this species along the Tsitsikama coast has been known for a long time by the local population and the staff of the Tsitsikama Coastal National Park (Robinson *pers. comm.*). Because so little was known about these otters, Dr Robinson, then Warden of the Park, requested the present research project.

The stretch of coastline between the two Groot Rivers (Oubosstrand and Nature's Valley) was declared a National Park in 1964. Before that, the area had been administered by the Department of Forestry. Except for local anglers, who had tracks down the escarpment, the area had been relatively inaccessible. By enquiring from the local anglers, it appeared that the otters had never been disturbed during this time, at least as far back as they could remember. After the National Parks Board took over the area, the situation remained unchanged. The Tsitsikama Coastal National Park was therefore an ideal area in which to study these animals.

Although it is apparently not generally known in South Africa, all otters skins, including those of Aonyx capensis are in large demand by the international fur trade (Smithers* pers. comm.). Some areas in Botswana were apparently nearly depleted of otters at the beginning of this century, and thousands of skins were sent to England (Bryden 1936). Today most skins of Aonyx still appear to come from Botswana (Smithers pers. comm.). Aonyx capensis is therefore a commercially valuable species, and an increase in demand for skins might have negative results on population sizes of otters in this country. Furthermore they are often disliked and persecuted by farmers, especially fish farmers. In the Orange Free State, a fair number are killed annually on an organised basis (Bester** pers. comm.). The effect this has on population sizes is probably very limited, but it is not known.

As has been shown in England (MacDonald et al. 1978), changes in habitat may perhaps have more effect than hunting.

It is thus important that otters should be studied at this stage, before an obvious decline in numbers becomes evident, rather than after such a decline, as was the case in England.

* Dr R H N Smithers, Mammal Research Institute, University of Pretoria

** J Bester, Department of Nature Conservation, Provincial Administration of the Orange Free State.

## TAXONOMY

Order Carnivora

Suborder Fissipedia

Family Mustelidae

Subfamily Lutrinae

Genus *Aonyx* Lesson, 1827

*Aonyx capensis* (Schinz, 1821)

*A. c. capensis* (Schinz, 1821)

The genotype of the Cape clawless otters was described as *Aonyx delalandi* by Lesson in 1827 (in Shortridge 1934), although Schinz had named the species *Lutra capensis* six years previously (Shortridge 1934). Most prominent authors have since then accepted the name *Aonyx capensis* (Schinz, 1821)(Shortridge 1934, Roberts 1950, Dorst and Dandelot 1970 and others). Murray (1860)(in Shortridge 1934), described the species as *Anahyster calabaricus*, but this has apparently never been accepted. In his revision of the Carnivora, Coetzee (1977) also used *Aonyx capensis* (Schinz 1821), and subdivided the species into three subspecies : *A. c. capensis* (Schinz, 1821), *A. c. hindei* (Thomas, 1905) and *A. c. meneleki* (Thomas 1903). The distribution of *A. c. capensis* is given as southern- and West Africa, that of *A. c. hindei* as Uganda to the eastern Congo and that of *A. c. meneleki* as Ethiopia.

Clawless otters occurring in the Congo basin were recognised by Coetzee (1977) as the only other species of *Aonyx*, viz. *Aonyx congica* (Lönnberg 1910).

## DISTRIBUTION

*Aonyx capensis* is to be found in or near almost any form of permanent fresh water, i.e., rivers, streams, swamps, dams and lakes on most of the African continent south of the Sahara (Figure 1). The areas from which it is conspiciously absent, are mainly the south-western and eastern deserts, because of the lack of permanent water, and the Congo basin, where it is apparently replaced by *A. congica* (Coetzee 1977). The gap in the distribution in northern Mocambique is probably due to lack of collecting (Smithers *pers. comm.*), but the absence of the species in the Zambezi valley east of the Victoria Falls, is difficult to explain.

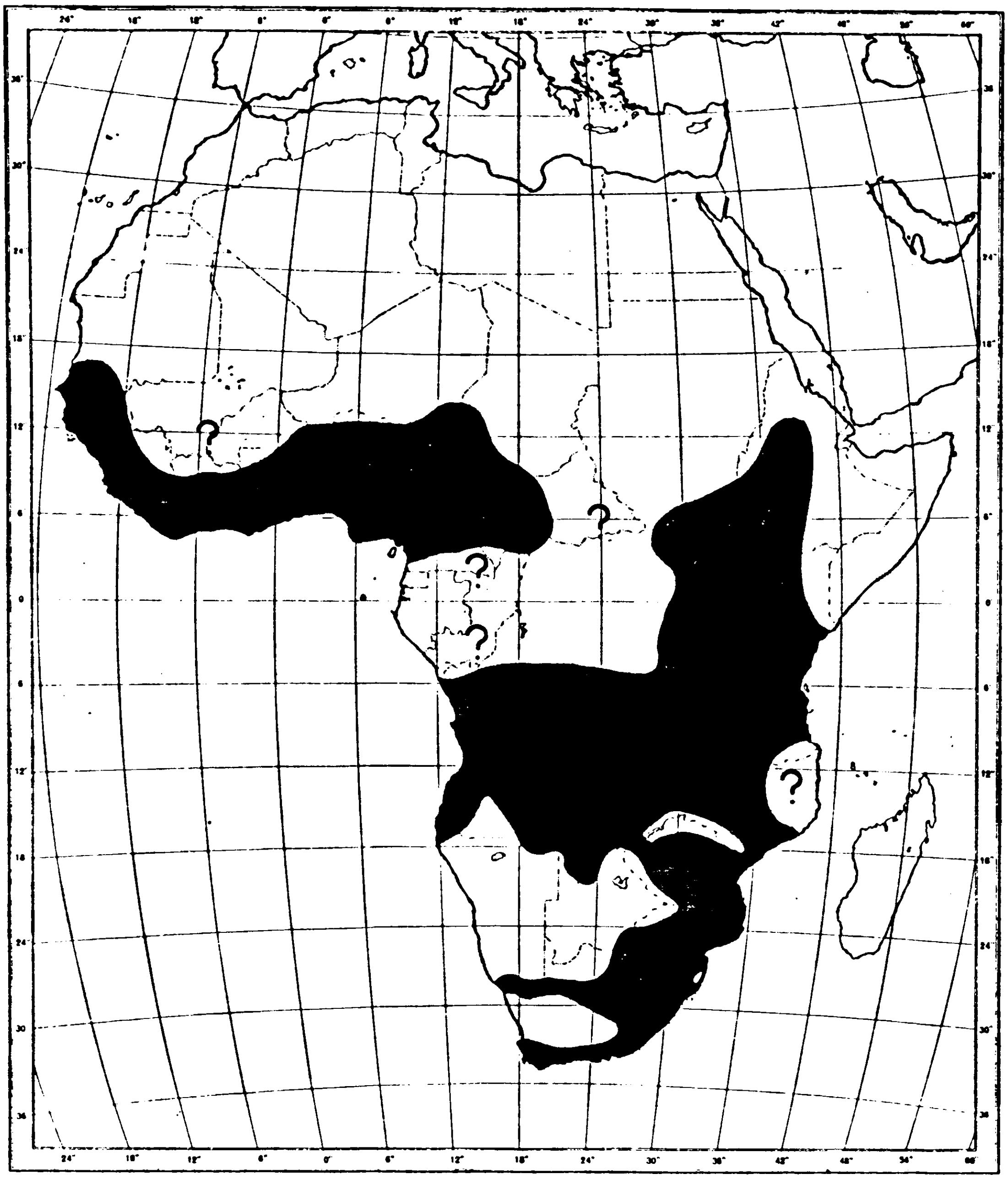


Fig. 1 The distribution of Aonyx capensis (Schinz, 1821) in Africa.
Compiled by R H Smithers.

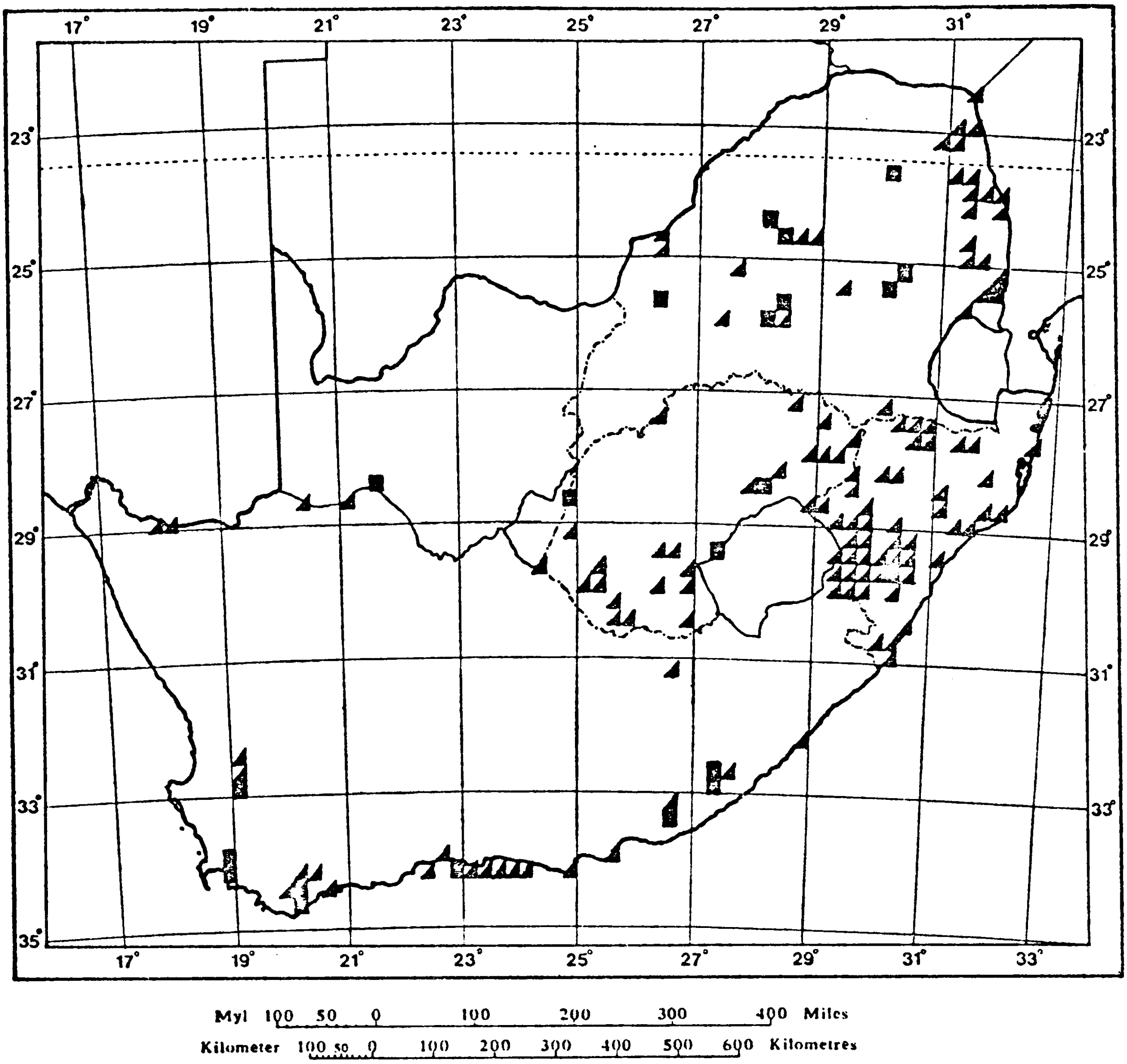



Fig. 2 Distribution of Aonyx capensis (Schinz, 1821) in South Africa. Data from Lynch (1975), Pringle (1977), Stuart (1977), Rowe-Rowe (1978), Stuart, Palmer and Munnik (1978), Rautenbach (1979) and own observations.

■ = specimen

◢ = other record

In South Africa (Figure 2), Aonyx capensis occurs throughout most of the Transvaal, Orange Free State and Natal. It is apparently absent from the north-western Transvaal and north-eastern Natal. The absence in the western Limpopo Valley may be related to the dryness of that area. The aeolic sands of north-eastern Natal support a generally depauperate mammal fauna, at least in numbers. It may further be that the lack of mud in Tongoland waters prevents colonisation by crabs, an important item in the diet of otters.

In the Cape Province, clawless otters are apparently absent from a large part of the Karroo, but they occur along the Orange River to the Atlantic Ocean.

Shortridge (1934) mentions the occurrence of clawless otters in tidal creeks and estuaries, while several authors have reported them from the southern Cape coast (Fitzsimmons 1919, Stuart, Palmer and Munnik 1978). I have found faeces of the species along the Transkei coast at Dwesa National Park, while Cooper*(pers. comm.) reported them from the Natal coast.

## DIMENSIONS

Nine individual otters could be measured and weighed, some of them several times. The results (Table 19, page 114) are compared with measurements from elsewhere in the South African subregion in Table 1.

It would appear that the coastal otters may be slightly smaller than the inland otters. Sample sizes, however, are too small for this to be significant. Student's t test does not elucidate a significant difference between the dimensions ($p > 0,05$). The maximum length of 1 800 mm measured by Smithers (pers. comm.) far exceeds the maximum length of 1 280 mm measured in Tsitsikama. Furthermore Shortridge (1934) mentions otters caught at the Pirie Trout Hatchery near King William's Town weighing up to 28,5 kg, which far exceeds the maximum weight of 16,4 kg at Tsitsikama. It is possible, however, that larger individuals occur at Tsitsikama, but that they were just not caught. The size of the traps used may also have had some influence on the size of otters caught.

* K H Cooper, Wildlife Society of Southern Africa.

TABLE 1

Comparison between the dimensions of Cape clawless otters caught in the Tsitsikama Coastal National Park with those from elsewhere in the South African subregion.

| | Tsitsikama National Park | | King William's Town district* | | Transvaal+ | | Northern parts[i] | |
|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female |
| n | 7 | 2 | 7 | 2 | 2 | 2 | 9 | 2 |
| Total length (mm) ($\bar{n}$) | 1216 | 1215 | 1328 | 1343 | 1240 | 1259 | 1313 | 1570 |
| range | 1130 – 1280 | 1145 – 1285 | 1260 – 1420 | 1245 – 1440 | 1235 – 1244 | 1168 – 1350 | 1110 – 1800 | 1170 – 1970 |
| Tail length (mm) ($\bar{n}$) | 512 | 488 | 525 | 578 | 476 | 453 | 501 | 530 α |
| range | 475 – 570 | 480 – 495 | 470 – 570 | 485 – 670 | 475 – 476 | 431 – 475 | | |
| Weight (kg) ($\bar{n}$) | 13,1 | 12,4 | 17,5 (n=2) | 15 (n=1) | 13,3 | 12 | 12,3 | 14,3 |
| range | 10,0 – 16,4 | 11,7 – 13 | 16,8 – 18,2 | | 9,5 – 17 | 12 – 12 | | |

* Specimens in Kaffrarian museum.

\+ Specimens in Transvaal museum (Measured by I L Rautenbach).

i Measurements by R H Smithers.

STUDY AREA

The Tsitsikama Coastal National Park covers a stretch of about 60 km of coast along the Indian Ocean between the two Groot Rivers at 23$^{o}$ 30' E and 24$^{o}$ 15' E (Figure 41, page 119).

From the coast an escarpment of about 180 m rises very sharply. This escarpment is the edge of a wave cut coastal plateau which was cut to the foot of the Tsitsikama mountains; a distance of about 5 km in the west and 8 km in the east. At the foot of the mountains the plateau is about 275 m above sea level. The mountains then rise to a height of between 1 300 m and 1 676 m (Toerien 1976).

Sandstones and shales of the Gamtoos, Table Mountain and Bokkeveld series predominate in the area (Toerien 1976). Several large rivers, such as the Bloukrans, Storms- and Elands Rivers, originating in the mountains, have been carved deeply into these rocks. Numerous other smaller rivers and streams draining the coastal plateau flow over the escarpment into the sea. Duplex soils (sand or loam over clay) are very common in this area.

Rainfall, mainly of cyclonic and orographic origin, is fairly evenly distributed throughout the year, with slight peaks in autumn and spring (Figure 3). It is very high in the mountains and decreases down to the coast (Schulze 1974). Average annual rainfall at the Storms River Mouth from April 1974 to March 1979 was 913 mm, while higher up on the plateau at the Storms River Forestry Station the average of 92 years (1883 - 1975) was 1 119 mm. This rainfall is responsible for an ample supply of perennial fresh water to the coast.

Temperatures in the area are mild, with average daily minimum ranging from about 9$^{o}$C in August to 17$^{o}$C in January, and average daily maximum ranging from about 18$^{o}$C in August to 24$^{o}$C in January (Figure 4). Frost is unknown here.

Average monthly sea temperature varies from about 15$^{o}$C to 22$^{o}$C, but the temperature sometimes drops down to about 10$^{o}$C after easterly winds (Figure 5).

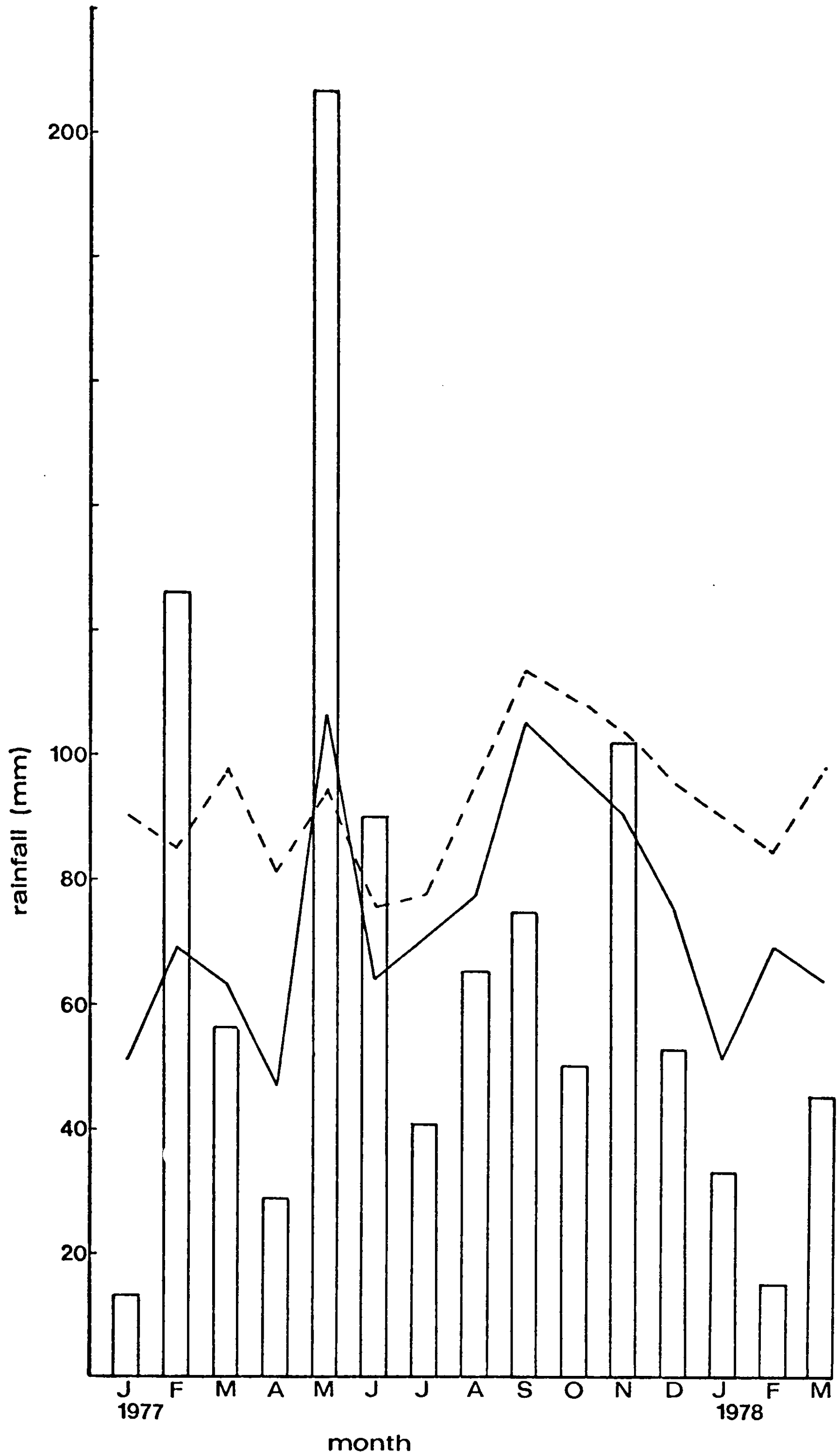



Fig. 3 Monthly distribution of rainfall at Storms River Mouth and Storms River Forestry station.

histogram : Monthly rainfall at Storms River Mouth during the study period

——————— Average monthly rainfall at Storms River Mouth from April 1974 to March 1979

- - - - - Average monthly rainfall at Storms River Forestry station from 1883 to 1975

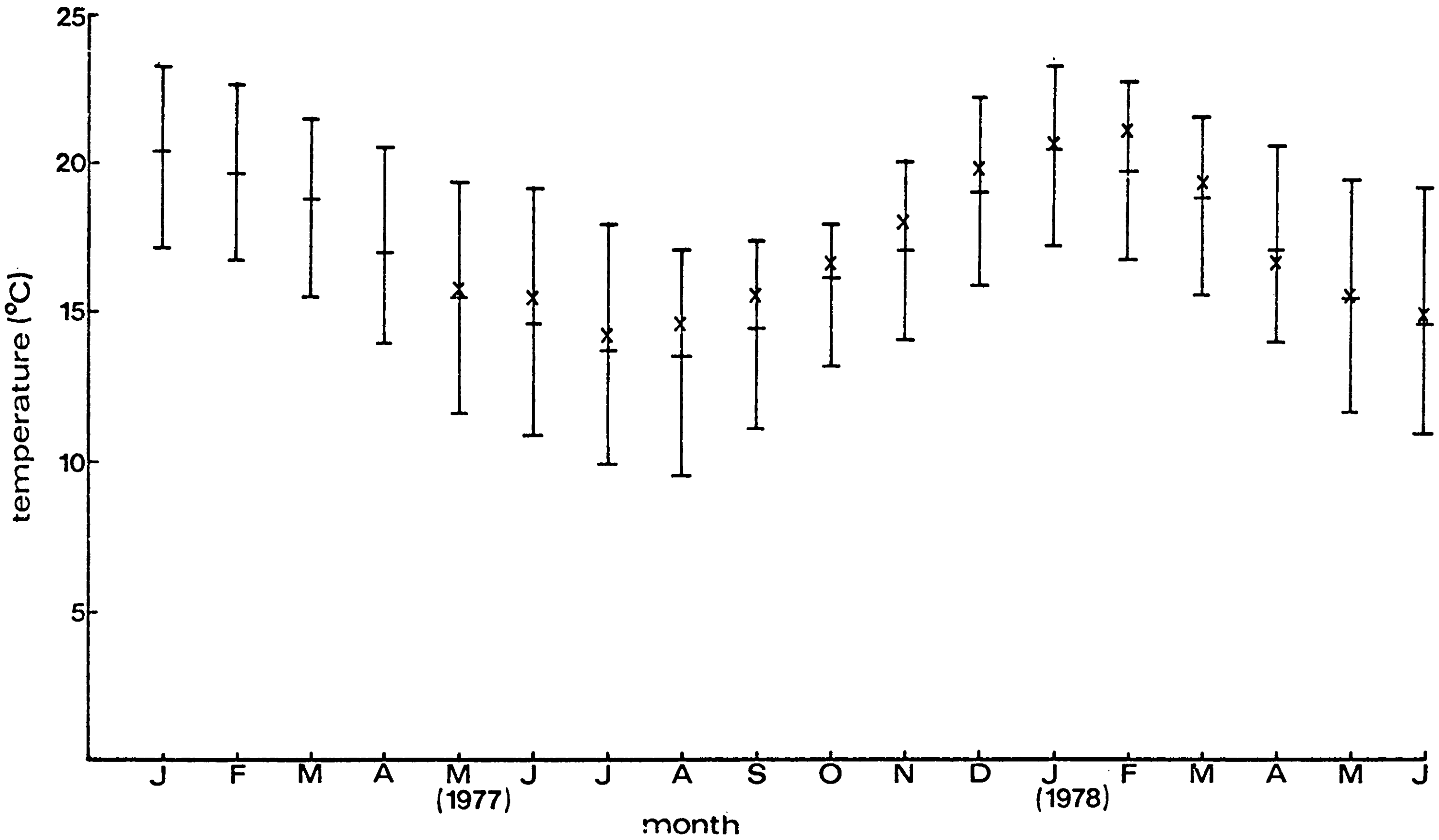



Fig. 4 Average, average minimum and average maximum monthly air temperatures at Storms River Mouth 1969 to 1975, and average monthly air temperature during part of the study period (x)

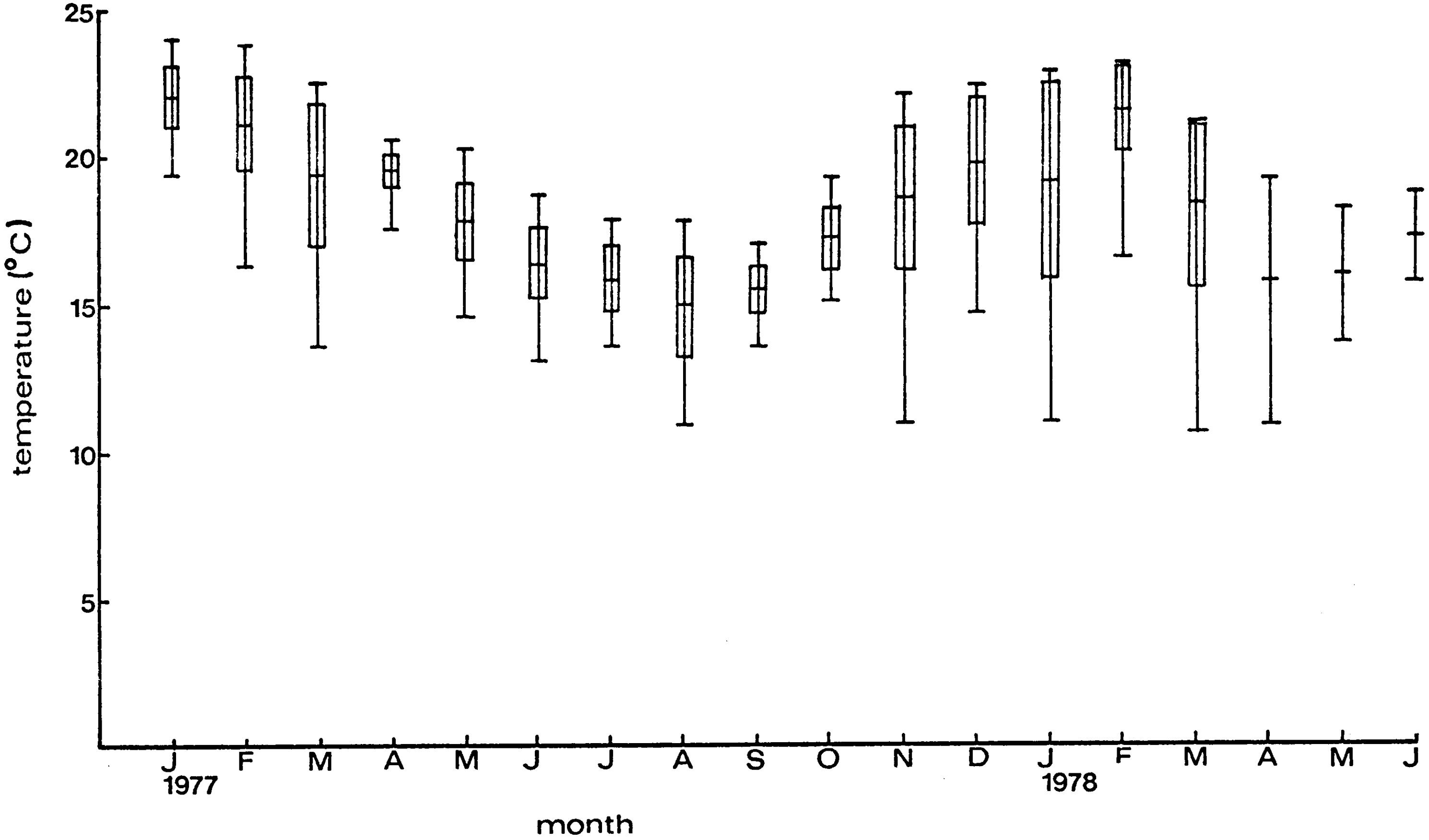



Fig. 5 Minimum, maximum and average monthly sea temperatures with their standard deviations recorded at Storms River Mouth during the study period.

The face of the escarpment is covered mainly by various types of dry shrub and forest (Von Breitenbach 1974), interspersed by macchia. Flat littoral areas are often covered by aromatic herbaceous composites or grass. On top of the escarpment macchia, moist forests and pine plantations predominate.

Characteristic species of the dry littoral shrub are Passerina falcifolia, Polygala myrtifolia, Tarchonanthus camphoratus and Maytenus heterophylla, while dry forest species include Pterocelastrus tricuspidatus, Cassine peragua, Rhus chirindensis, Sideroxylon inerme and Cassine aethiopica. Carissa bispinosa is an important component of the shrub layer here, and together with Dovyalis rhamnoides can make passage through the bush decidedly uncomfortable. Where streams or rivers pass through dry forest, elements of wetter forests, such as Platylophus trifoliatus, Cunonia capensis and Alsophila capensis are sometimes present. The macchia consists to a large extent of Berzelia, Brunia and Erica spp., but other notable species include Protea neriifolia, P. cynaroides, Leucadendron salignum, Laurophyllus capensis and various Iridaceae, Liliaceae and Orchidaceae.

Three species of Viverridae, two Bovidae, two Cercophithecidae and one Suidae are common in the Park. These are the genet Genetta tigrina, water mongoose, Atilax paludinosus, Cape grey mongoose Herpestes pulverulentus, bushbuck Tragelaphus scriptus, blue duiker Cephalophus monticola, baboon Papio ursinus, vervet monkey Cercopithecus pygerythrus and the bush pig Potamochoerus porcus. Grysbuck Raphicerus melanotis were occasionally seen in macchia outside the Park, but once in forest inside the Park. Caracal Felis caracal and leopard Panthera pardus have been reported from the park (Robinson 1976), and tracks of leopard were actually seen fairly frequently. A complete list of mammals found in the park was compiled by Robinson (1976).

Of the larger raptors in the Park, the fish eagle Halietus vocifer, the mountain buzzard Buteo buteo and the African hawk eagle Aquila fasciata were frequently seen. A crowned eagle Polemaetus coronatus was seen once.

# FEEDING ECOLOGY

## INTRODUCTION

Many studies on otter spraint analysis have been published (Lagler and Ostenson 1942, Greer 1955, Ryder 1955, Sheldon and Toll 1964, Knudsen and Hale 1968, Fairley 1972, Fairley and Wilson 1972, Toweill 1974, Webb 1976). From these it is apparent that Lutra canadensis, the North American otter, as well as Lutra lutra, the European otter, prey mainly on fish, while the remainder of their diet is made up to a varying extent of crayfish, amphibians, some birds, mammals and invertebrates. All the studies cited on Lutra lutra were carried out in the British Isles and not one of these covered more than a year, while some covered only one season. The lack of detail is significant, while very little reference is made to the importance of prey availability.

Stephens (1957) made a somewhat more extensive study on otters in England, based partly on faecal analysis and partly on a literature survey, while the food of otters in the Netherlands is mentioned in the report of Van Wijngaarden and Van de Peppel (1970), based mainly on a literature survey.

The first, and so far the only, extensive studies on the feeding ecology of Lutra lutra were carried out by Erlinge (1967a, 1968a, 1969 and 1972) in Sweden. For the first time feeding habits were related to frequency and activity of prey species.

In Africa there is greater paucity of information. Except for a few occasional notes on prey of the 3 species of otter occurring here, (Shortridge 1934, Dorst and Dandelot 1970, Smithers 1971, Kingdon 1977) coming down to a diet of fish in the case of Lutra maculicollis, and a nearly completely omnivorous diet in the case of Aonyx capensis, virtually nothing was known about the diet of otters prior to the research of Rowe-Rowe (1975, 1977a,b,c). Rowe-Rowe made a relatively extensive study of the feeding ecology of both species in Natal, although little information was presented on the availability of prey.

The feeding ecology of otters in a marine environment has recently been the subject of investigations along the Scottish coast (Jenkins, Walker and McCowan 1979, Watson 1978). In Africa Tayler (1970) gave a very elementary account on food taken by Aonyx capensis along the coast near Port Elizabeth.

The object of this section is three-fold. First, to give a detailed account of the food of otters along the Tsitsikama coast; secondly, to present a discussion on various techniques used for faecal analysis; and thirdly, by relating the numbers of prey species eaten to the number observed in the inter- and infratidal zones, to examine the feeding strategy of Aonyx capensis.

## MATERIALS AND METHODS

Spraints were collected along the coast, but mostly between Steilkop (about 2 km east of Storms River) and Rietmondjie, (about 3,5 km west of Storms River). They were collected daily to monthly, depending on the accessibility of the otter holts and other factors. At first all spraints were analysed, but this proved unnecessary. After February 1977, all spraints were still collected, but from these as random a sample as possible was selected. Sample size was first reduced to about 100 and later to about 50.

"Spraint" refers to anything from a small dropping of about 3 g to a collection of several droppings which could not be discerned, up to 100 g or more. The average dry weight of all spraints was 10,9 g.

The spraints were collected in small plastic bags and taken to the laboratory where they were washed under a tap in a 1 mm sieve. They were then left on newspaper on drying boards to dry.

A total of 1 251 spraints was analysed, varying from 22 to 201 per month (Table 2). Each spraint was analysed as follows :

1. Hard parts of prey items were identified as effectively as possible. The different prey categories recorded are listed in Table 3.

TABLE 2

Monthly number of spraints analysed : January 1977 - March 1978

| Month | No. | Total dry weight (g) |
|---|---|---|
| January | 148 | 1923 |
| February | 201 | 1954 |
| March | 99 | 748 |
| April | 114 | 918 |
| May | 98 | 857 |
| June | 107 | 1020 |
| July | 106 | 1198 |
| August | 50 | 485 |
| September | 57 | 621 |
| October | 55 | 741 |
| November | 45 | 790 |
| December | 49 | 535 |
| January | 50 | 740 |
| February | 50 | 805 |
| March | 22 | 287 |
| TOTAL | 1 251 | 13 622 |

TABLE 3

Scientific and common names of all prey species/categories identified in the diet of *Aonyx capensis*.

| SCIENTIFIC NAME | FAMILY | COMMON NAME |
|---|---|---|
| *Plagusia chabrus* | Grapsidae | Red rock crab |
| *Cyclograpsus punctatus* | Grapsidae | Brown rock crab |
| *Jasus lalandii* | Palinuridae | Cape rock lobster |
| *Potamon perlatus* | Potamonidae | Fresh-water crab |
| Other Crustacea | | Shrimps, beach lice, etc. |
| *Octopus granulatus* | Octopodidae | Common octopus |
| *Sepia tuberculata* | Sepiidae | Squid |
| *Chorisochismus dentex* | Gobiesocidae | Rocksucker (fish) |
| *Apletodon knysnaensis* | Gobiesocidae | Suckerfish |
| Clinidae | Clinidae | Klipfishes |
| *Clinus cottoides* | Clinidae | |
| *Clinus superciliosus* | Clinidae | |
| *Clinus capensis* | Clinidae | |
| *Clinus anguillaris* | Clinidae | |
| *Pavoclinus graminis* | Clinidae | |
| *Pavoclinus pavo* | Clinidae | |
| *Clinus taurus* | Clinidae | |
| Unidentified Clinidae | Clinidae | |
| *Blennius cornutus* | Blenniidae | Blenny |
| *Blennius fascigula* | Blenniidae | Blenny |
| *Acanthistius sebastoides* | Serranidae | Koester |
| *Epinephelus guaza* | Serranidae | Yellowbelly |
| *Epinephelus andersoni* | Serranidae | Spotted rockcod |
| Unidentified Serranidae | Serranidae | Rockcod |
| *Palunolepis brachydactylus* | Cheilodactylidae | Butterfish |
| *Cheilodactylus fasciatus* | Cheilodactylidae | Steenvis |
| *Diplodus sargus* | Sparidae | Dassie |
| *Sparodon durbanensis* | Sparidae | Musselcracker |
| *Rhabdosargus tricuspidens* | Sparidae | Stumpnose |
| *Lithognathus mormyrus* | Sparidae | Sand steenbras |
| *Sarpa salpa* | Sparidae | Strepie |
| *Boopsoidea inornata* | Sparidae | Cape lady |
| *Spondyliosoma emarginatum* | Sparidae | Steentjie |
| *Pagellus natalensis* | Sparidae | Red grunter |
| Unidentified Sparidae | Sparidae | Unidentified Dassie-type fish |
| *Pomadasys olivaceus* | Pomadasyidae | Varkie |
| *Liza richardsoni* (?) | Mugilidae | Springer |
| Anura | | frogs |
| | | Water beetle |
| | | Pill millipede |
| | | Unidentified |

2. A visual estimate was made of the percentage of the total volume of the spraint made up by each different category.

3. The spraint was weighed.

4. The pincers of crabs, premaxillas of fishes and beaks of octopuses were measured (two measurements each).

From material obtained from spraints, the relative weight of crab shells, fishbones, etc., was determined and expressed as a ratio of the weight of crabshells.

Two methods of analysis were used :

1. Frequency analysis
   The presence of each prey category in each spraint was scored. Scores for each different category were added monthly and expressed in two ways :
   (a) As a percentage of the total number of spraints for the month, giving percentage frequency.
   (b) As a percentage of the total number of scores of all categories for the month, giving relative percentage frequency.

2. Bulk-weight analysis

   The relative volumes of all categories in each spraint were converted to relative weights by multiplying with corrective factors, mentioned previously, and with the weight of the spraint known, absolute weights of all the categories were estimated. All the weights of every category were added monthly and then expressed as a percentage of the total weight of all the sprints of the month. *Octopus* was excluded from this analysis due to the lack of remains except the small beaks.

Regressions were computed between the sizes of the main prey organisms and the sizes of their remains measured in spraints, where the last was used as estimator of the first. The fish and other prey items needed to obtain the measurements became available during sampling with rotenone (see later). Four regressions were computed for every prey organism, viz. linear-linear, log-linear, linear-log and log-log. The regression with the lowest standard error of estimate was used. From the measurements of remains in spraints the actual sizes of prey items eaten could then be estimated. Two measurements were taken of every pincer, premaxilla and beak, and for each a regression was computed. From each measurement the actual size was estimated, and the average between the two estimates was used as final estimate, wherever this was possible.

From these data frequency distributions of size classes of prey animals eaten could be obtained. Average monthly size taken was estimated for all major prey items, and these data were used to extend the calculations in bulk-weight -, as well as frequency analysis. The two methods were ultimately combined to obtain a final estimate of relative numbers and weight of prey consumed.

Some additional information on feeding was obtained by collecting the few uneaten remains of prey items at holts.

IDENTIFICATION OF REMAINS IN SPRAINTS

1. Crabs : Only two species were present in any numbers, and they were easy to distinguish by means of differences in colour and texture. Occasional swimming crabs were found but these were not represented in the diet of otters.

2. Octopuses : Only one species was present, or at least could be found, viz. Octopus granulatus. Remains of Octopus in spraints consisted of the beaks, and frequently half-digested suckers and tentacles. Only the beaks were used for analysis.

3. Fish were all identified by their bones. As the main prey fishes, rocksuckers, clinids and blennies, have no scales or very small scales, scales were not used for analysis.

Fish were at first obtained from anglers or caught by hand, but later became available during sampling with rotenone. One individual of every species was cooked up and the bones mounted on a reference card (Figure 6) Fish remains in spraints were identified from these cards.

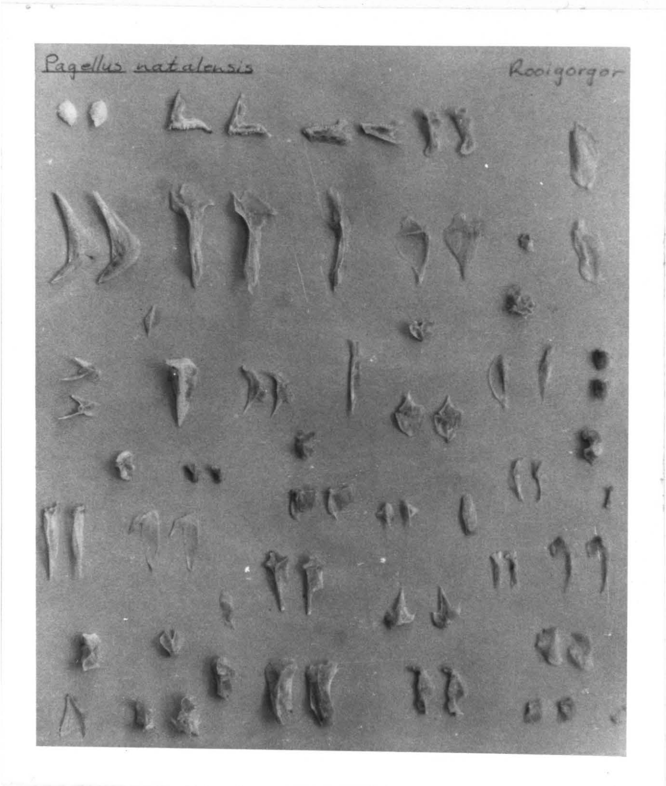



Fig. 6 Example of a reference card used for the identification of fish bones.

The ratio between live weight and dry weight of hard (undigestible) parts of red rock crabs and a few fish species were determined as follows :

After having been measured and weighed, a few crabs and fish were cooked for a few minutes until the soft parts were easily removed. Soft parts were then carefully removed from all shells or bones by means of a forceps, and the hard parts washed. The hard parts were then left to dry at room temperature and weighed. The ratio was obtained by dividing the original wet weight of the crab or fish by the dry weight of the hard parts. By applying these ratios, the weight of hard parts in spraints was converted to estimated live weight eaten.

To get some idea of availability of prey items, a programme was set up to sample certain areas along the coast by means of rotenone (1, 2, 12, 12a - Tetrahydro-8,9-dimethoxy-2-(1-methylethenyl)-[1] benzopyrano [3,4-b] furo [2,3-h] [1]-benzopyran-6(6H)-one). This well-known insecticide and ichthyocide prevents respiration by inhibiting oxidative phosphorylation. Sampling commenced by pouring approximately 5 to 25 $m\ell/m^2$ of rotenone into the water, depending on the condition and depth of the water. If a fair amount of motion was present, about 10 $m\ell/m^2$ was poured in two to four times at five minute intervals. Immediately after adding the rotenone, the water was stirred by hand to spread it over the required area. A few minutes after the first dose small fishes would surface, already affected, and as many of these as possible were caught with a net. Somewhat later (± 10 minutes) octopuses and crabs would also start moving, and these too, were collected. Affected fish, octopuses and crabs were caught up to about 30 minutes after sampling, after which everything would be dead or nearly dead. With the aid of goggles and a snorkle the poisoned area was then systematically searched to recover all dead animals. Everything had to be recovered before the tide came in. All animals were measured and weighed while still fresh.

All Crustacea and Mollusca were identified according to Day (1974). The classification system of Penrith (1965) and Christensen (1978b) was used for the Clinidae, while other fish were identified according to Smith (1965) or Smith & Smith (1966). Tietz and Robinson (1974) proved valuable in identifying various other organisms.

Observations on feeding behaviour were made on otters in the wild, as well as a tame otter (owned by Dr Robinson, Warden of the Park).

Ivlev's electivity index (Ivlev, 1961) was used to give a clear visual idea of selectivity of prey items and/or size classes :

$$E = \frac{P_d - P_f}{P_d + P_f}$$

where $P_d$ = proportion of each prey item in diet

$P_f$ = proportion of each prey item in the field.

Percentage weight of remains of prey items in spraints was mostly taken as $P_d$, whereas percentage of total collection with rotenone was taken as $P_f$.

Positive selection is expressed by values from +1 to 0, absence of selection by 0, and negative selection by values from 0 to -1.

Although this index has its disadvantages, it was selected out of eight indices (Cock, 1978) because of its applicability to this study, where many species were preyed upon. The other indices were only applicable to two-prey situations.

## RESULTS

From January 1977 to December 1977, a total of 1 129 spraints was collected, while a further 122 were collected until March 1978.

For an in-depth study on feeding habits a time span of two years is usually considered necessary (Korschgen, 1971), but time did not allow this. Most of the studies on feeding ecology to which Korschgen refers, however, were carried out in terrestrial or inland aquatic habitats, where seasonal variation may be extreme. The marine intertidal zone of the Tsitsikama Coastal National Park is probably subjected to far less fluctuation in temperature and no seasonal fluctuation in water level. This is reflected in the analysis of spraints. Although some variation occurred in the diet of otters at Tsitsikama (see later), it was not nearly as marked as in inland habitats, where similar studies have been made (Rowe-Rowe 1975, 1977a). From the data available up to March 1978, therefore, it was decided that further analysis of spraints was not really necessary.

To determine the availability of prey animals in the inter- and infratidal zones, rotenone proved to be very effective, as all the organisms of importance in the diet of otters were killed by this poison. Unfortunately, many other organisms, such as Echinoderms, Polychaetes and some Molluscs were killed as well. Many shelled Molluscs, however, excaped the effects of rotenone, probably due to the protection of their shells. It is not known whether red bait (Pyura stolonifera) was affected. A great advantage of this poison is that it is soon decomposed and therefore does not remain toxic very long (Penrith 1965).

Two main areas were chosen for the rotenone program, while a few additional areas were sampled to gain further information.

Area 1 was an intertidal pool, situated more or less in the cochlear zone, directly south-west of the main caravan park (Figure 7). This pool is inundated and exposed to wave action most of the time and is only accessible during spring low tides. Even then the water may still be in motion if the weather is unfavourable. The estimated surface area of the water in this pool at spring low tide is about 15 $m^2$. The depth of the pool at spring low tide varies between about 100 and 1 000 mm. A fair amount of loose rocks, small to large, as well as a dense growth of Sargassum heterophyllum, a common, large seaweed, was present, offering a lot of shelter. During the sampling of March 1978, all this Sargassum had disappeared, but it was again present in July 1978. The polychaete Pomatoleios kraussii was extremely abundant above the pool. Red bait, as well as the typical algae usually associated with it, was absent.

Sampling was started in June 1977 and repeated four times about every three months, with the last sampling being done on 2 July 1978. As all mobile animals were killed during every sampling, all samplings after the first one were indications of migration into the pool.

Fig. 7    Area 1, the intertidal pool used for regular sampling.

Fig. 8    Area 2, the subtidal area used for regular sampling.

This pool was selected for four main reasons :

1. It was within the main study area.
2. It was inundated most of the time, therefore no barrier against migration was present.
3. It was directly in front of an otter holt.
4. An otter had actually been observed hunting in the area.

The results of sampling in Area 1 are shown in Table 4.

Area 2 was a general area about 200 m west of Area 1 in the infratidal zone (Figure 8). This area was also sampled five times, but every sampling was carried out in a new subsection of the area. A few problems were associated with this. To avoid sampling in an area which might have been exposed to poison previously, the five subsections had to be some distance apart, as the poison spreads further than the actual sampling area. Furthermore the subsections were to be as uniform as possible, to avoid the influence of different habitat types. The other problem was that the sea had to be very calm during sampling, as in this case open areas of water near the open sea were sampled. The area was also only accessible during spring low tide.

Uniformity of habitat was regarded as satisfactory in the case of the first four samplings (this was the best area that could be found). These four subsections were all infratidal, with only very large rocks present. Shelter was available in numerous cracks under and between the large rocks, and between the prolific growth of seaweed. In all four areas red bait was also common. Brown mussels (Perna perna) were present in large numbers on the rocks exposed during spring low tide. Sandy bottoms, or at least patches of sand were present in the first four subsections.

The last sampling was done during a visit of only one week in July 1978, during which the weather proved to be unfavourable. Although it was spring low tide, sampling in a subsection similar to the first four proved impossible, and consequently a more sheltered area had to be selected. This subsection was still in the same general area, but habitat conditions were different. It was situated more towards the cochlear zone and was surrounded by rocks. No red bait or mussels were present. Even in this relatively protected area the water was still in motion, causing rapid dilution of the poison. The result was that a few of the larger crabs and fish were not killed.

After a sampling, the area around the sampling section was searched for any dead organisms to determine the maximum range of the poison. The next sampling was then done well out of this range.

The problem of water motion has already been mentioned. During 1977 and up to March 1978, one out of several spring low tides could be selected every time, something which was impossible during July 1978. The result was that conditions during the first four samplings were relatively satisfactory. Water motion was never completely absent however, and this necessitated the use of more rotenone than in Area 1.

The reasons for choosing this area were similar to those for Area 1. The specific purposes of a second area were to have some form of "nondestructive" sampling and to sample the infratidal area.

The results of sampling in Area 2 are shown in Table 5.

The results of Areas 1 and 2 were combined to provide the information contained in Table 6.

The very first area to be sampled was actually a small, rather protected gully just west of cottage no. 8. This gully is fully tidal. At low tide it is nowhere deeper than about 50 mm, but a high tide it is completely inundated and indistinguishable. Only after it was noticed that the animals collected in this gully did not reflect the diet of otters, as determined by spraint analysis up to then, was it decided to sample Areas 1 and 2. The results of sampling this area proved rather interesting however, as representative of a third kind of habitat. Table 7 summarises the results of two successive samplings in this gully, designated Area 3.

A fourth habitat which could be distinguished was not sampled. This type consists of deep, protected pools, which are only occasionally subjected to turbulence. By diving in such pools, it was found that the fauna include many larger Clinus superciliosus and Palunolepis brachydactylus, and also Cheilodactylus fasciatus, Blennius fascigula and various common Sparidae, such as Diplodus sargus, Sarpa salpa and Sparodon durbanensis.

The results of the two methods of analysis, frequency analysis and bulk-weight analysis, are presented in Tables 8 and 9. Frequency is expressed as a percentage of all occurences, or relative percentage frequency.

Referring to Tables 4 to 9 , each of the prey species or categories will now be discussed separately.

TABLE 4

Animals collected with rotenone in Area 1 (Intertidal pool).

| Species | 10 June | | 29 September | | 27 December | | 10 March | | 5 July | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | no. | % | no. | % | no. | % | no. | % | no. | % | no. | % |
| Plagusia chabrus | 40 | 15,4 | 42 | 24,3 | 40 | 22,6 | 28 | 33,7 | 27 | 20,5 | 177 | 21,5 |
| Octopus granulatus | 8 | 3,1 | 6 | 3,5 | 15 | 8,5 | 8 | 9,6 | 7 | 5,3 | 44 | 5,3 |
| Sepia tuberculata | 1 | 0,4 | | | 1 | 0,6 | 2 | 2,4 | | | 4 | 0,5 |
| Clinus cottoides | 108 | 41,7 | 66 | 38,2 | 71 | 40,1 | 17 | 20,5 | 64 | 48,5 | 326 | 39,6 |
| Clinus superciliosus | | | 3 | 1,7 | 8 | 4,5 | 3 | 3,6 | 4 | 3,0 | 18 | 2,2 |
| Clinus capensis | 8 | 3,1 | 5 | 2,9 | 3 | 1,7 | 2 | 2,4 | 2 | 1,5 | 20 | 2,4 |
| Clinus anguillaris | | | 3 | 1,7 | | | | | 1 | 0,8 | 4 | 0,5 |
| Clinus striatus | 1 | 0,4 | | | | | | | | | 1 | 0,1 |
| Pavoclinus graminis | 21 | 8,1 | 8 | 4,6 | 2 | 1,1 | 5 | 6,0 | 6 | 4,5 | 42 | 5,1 |
| Pavoclinus pavo | 7 | 2,7 | 3 | 1,7 | 11 | 6,2 | | | 2 | 1,5 | 23 | 2,8 |
| Blennioclinus brachycephalus | | | | | 1 | 0,6 | | | | | 1 | 0,1 |
| Total Clinidae | 145 | 56,0 | 88 | 50,9 | 96 | 54,2 | 27 | 32,5 | 79 | 59,8 | 435 | 52,8 |
| Chorisochismus dentex | 39 | 15,1 | 16 | 9,3 | 7 | 4,0 | 4 | 4,8 | 7 | 5,3 | 73 | 8,9 |
| Apletodon knysnaensis | 9 | 3,5 | | | | | | | 1 | 0,8 | 10 | 1,2 |
| Blennius cornutus | 12 | 4,6 | 2 | 1,2 | 10 | 5,7 | 4 | 4,8 | 5 | 3,8 | 33 | 4,0 |
| Blennius fascigula | 1 | 0,4 | 2 | 1,2 | | | | | | | 3 | 0,4 |
| Chaladoderma capito | | | 1 | 0,6 | | | | | | | 1 | 0,1 |
| Palunolepis brachydactylus | 1 | 0,4 | 2 | 1,2 | 2 | 1,1 | 4 | 4,8 | 3 | 2,3 | 12 | 1,5 |
| Palunolepis grandis | | | 3 | 1,7 | | | | | | | 3 | 0,4 |
| Cheilodactylus fasciatus | | | | | 3 | 1,7 | 1 | 1,2 | | | 3 | 0,5 |
| Acanthistius sebastoides | 1 | 0,4 | | | 1 | 0,6 | 1 | 1,2 | | | 3 | 0,4 |
| Epinephelus guaza | 1 | 0,4 | | | | | | | | | 1 | 0,1 |
| Diplodus sargus | | | 7 | 4,1 | | | | | 2 | 1,5 | 9 | 1,1 |
| Sparodon durbanensis | | | 3 | 1,7 | 1 | 0,6 | 3 | 3,6 | | | 7 | 0,8 |
| Halidesmus scapularis | 1 | 0,4 | | | | | | | | | 1 | 0,1 |
| Leptocephalus | | | 1 | 0,6 | | | | | | | 1 | 0,1 |
| Gobius nudiceps | | | | | | | | | 1 | 0,8 | 1 | 0,1 |
| Unidentified fish | | | | | 1 | 0,6 | 1 | 1,2 | | | 2 | 0,2 |
| Total fish | 210 | 81,1 | 125 | 72,2 | 121 | 68,3 | 45 | 54,2 | 98 | 74,2 | 599 | 72,7 |
| TOTAL | 259 | | 173 | | 177 | | 83 | | 132 | | 824 | |

TABLE 5

Animals collected with rotenone in Area 2 (Infratidal area).

| Species | 13 August | | 26 October | | 26 December | | 25 March | | 2 July | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | no. | % | no. | % | no. | % | no. | % | no. | % | no. | % |
| Plagusia chabrus | 31 | 55,4 | 47 | 38,8 | 51 | 22,6 | 52 | 41,6 | 8 | 14,6 | 189 | 32,3 |
| Octopus granulatus | 1 | 1,8 | 2 | 1,7 | 6 | 2,6 | 6 | 4,8 | 2 | 3,6 | 17 | 2,9 |
| Sepia tuberculata | | | | | 1 | 0,4 | | | | | 1 | 0,2 |
| Clinus cottoides | 7 | 12,5 | 25 | 20,7 | 10 | 4,4 | 16 | 12,8 | 25 | 45,5 | 83 | 14,2 |
| Clinus superciliosus | | | 2 | 1,7 | | | 9 | 7,2 | 2 | 1,8 | 13 | 2,2 |
| Clinus capensis | 4 | 7,1 | 4 | 3,3 | 3 | 1,3 | | | 1 | 1,8 | 12 | 2,1 |
| Clinus acuminatus | | | | | 6 | 2,6 | | | | | 6 | 1,0 |
| Clinus robustus | | | | | 1 | 0,4 | | | | | 1 | 0,2 |
| Clinus anguillaris | | | | | | | 1 | 0,8 | | | 1 | 0,2 |
| Clinus striatus | | | 1 | 0,8 | | | | | | | 1 | 0,2 |
| Clinus taurus | | | | | 3 | 1,3 | | | | | 3 | 0,5 |
| Pavoclinus graminis | 6 | 10,7 | 2 | 1,7 | 28 | 12,4 | 10 | 8,0 | 5 | 9,1 | 51 | 8,7 |
| Pavoclinus pavo | 2 | 3,6 | 1 | 0,8 | 40 | 17,7 | 7 | 5,6 | 4 | 7,3 | 54 | 9,2 |
| Pavoclinus mus | | | | | 5 | 2,2 | | | | | 5 | 0,9 |
| Blennioclinus brachycephalus | | | | | 7 | 3,1 | 3 | 2,4 | 1 | 1,8 | 11 | 1,9 |
| Blennioclinus stella | | | | | 9 | 4,0 | | | | | 9 | 1,5 |
| Ophtalmolophus ? | | | 1 | 0,8 | | | | | | | 1 | 0,2 |
| Total Clinidae | 19 | 33,9 | 36 | 29,3 | 112 | 49,6 | 46 | 36,8 | 38 | 69,1 | 251 | 42,9 |
| Chorisochismus dentex | 1 | 1,8 | 19 | 15,7 | 25 | 11,1 | 9 | 7,2 | 1 | 3,6 | 55 | 9,4 |
| Apletodon knysnaensis | 1 | 1,8 | | | | | | | | | 1 | 0,2 |
| Blennius cornutus | 3 | 5,4 | 12 | 9,9 | 16 | 7,1 | 5 | 4,0 | 3 | 5,6 | 39 | 6,7 |
| Blennius fascigula | | | | | | | | | 1 | 1,8 | 1 | 0,2 |
| Palunolepis brachydactylus | | | | | 1 | 0,4 | 2 | 1,6 | | | 3 | 0,5 |
| Cheilodactylus fasciatus | | | 4 | 3,3 | | | 1 | 0,8 | 2 | 3,6 | 7 | 1,2 |
| Acanthistius sebastoides | | | 2 | 1,7 | | | | | | | 2 | 0,3 |
| Epinephelus guaza | | | 1 | 0,8 | | | | | | | 1 | 0,2 |
| Sarpa salpa | | | | | | | 3 | 2,4 | | | 3 | 0,5 |
| Tachysurus fossor | | | | | 14 | 6,2 | | | | | 14 | 2,4 |
| Heteromycteris capensis | | | | | | | 1 | 0,8 | | | 1 | 0,2 |
| Total fish | 24 | 42,9 | 74 | 59,5 | 168 | 74,3 | 67 | 53,6 | 45 | 81,8 | 378 | 64,6 |
| TOTAL | 56 | | 123 | | 226 | | 125 | | 55 | | 585 | |

TABLE 6

Combined results of collection with rotenone in areas 1 and 2

| Species | June–August | | Sept.-Oct. | | December | | March | | July | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | no. | % | no. | % | no. | % | no. | % | no. | % | no. | % |
| Plagusia chabrus | 71 | 22,6 | 89 | 30,1 | 91 | 22,8 | 80 | 39,0 | 35 | 18,7 | 366 | 26,0 |
| Octopus granulatus | 9 | 2,9 | 8 | 2,7 | 21 | 5,3 | 14 | 6,8 | 9 | 4,8 | 61 | 4,3 |
| Sepia tuberculata | 1 | 0,3 | 0 | 0 | 2 | 0,5 | 2 | 1,0 | | | 5 | 0,4 |
| Clinus cottoides | 115 | 36,6 | 91 | 30,7 | 81 | 20,3 | 33 | 16,1 | 89 | 47,6 | 409 | 29,1 |
| Clinus superciliosus | | | 5 | 1,7 | 8 | 2,0 | 12 | 5,9 | 6 | 3,2 | 31 | 2,2 |
| Clinus capensis | 12 | 3,8 | 9 | 3,0 | 6 | 1,5 | 2 | 1,0 | 3 | 1,6 | 32 | 2,3 |
| Clinus anguillaris | | | 3 | 1,0 | | | 1 | 0,5 | 1 | 0,5 | 5 | 0,4 |
| Clinus acuminatus | | | | | 6 | 1,5 | | | | | 6 | 0,4 |
| Clinus robustus | | | | | 1 | 0,3 | | | | | 1 | 0,07 |
| Clinus striatus | 1 | 0,3 | 1 | 0,3 | | | | | | | 2 | 0,1 |
| Clinus taurus | | | | | 3 | 0,8 | | | | | 3 | 0,2 |
| Pavoclinus graminis | 27 | 8,6 | 10 | 3,4 | 30 | 7,5 | 15 | 7,3 | 11 | 5,9 | 93 | 6,6 |
| Pavoclinus pavo | 9 | 2,9 | 4 | 1,4 | 51 | 12,8 | 7 | 3,4 | 6 | 3,2 | 77 | 5,5 |
| Pavoclinus mus | | | | | 5 | 1,3 | | | | | 5 | 0,4 |
| Blennioclinus brachycephalus | | | | | 8 | 2,0 | 3 | 1,5 | 1 | 0,5 | 12 | 0,9 |
| Blennioclinus stella | | | | | 9 | 2,3 | | | | | 9 | 0,6 |
| Ophtalmolophus ? | | | 1 | 0,3 | | | | | | | 1 | 0,07 |
| Total Clinidae | 164 | 52,2 | 124 | 41,9 | 208 | 52,0 | 73 | 35,6 | 117 | 62,6 | 686 | 48,8 |
| Chorisochismus dentex | 40 | 12,7 | 35 | 11,8 | 32 | 8,0 | 13 | 6,3 | 8 | 4,3 | 128 | 9,1 |
| Apletodon knysnaensis | 10 | 3,2 | | | | | | | 1 | 0,5 | 11 | 0,8 |
| Blennius cornutus | 15 | 4,8 | 14 | 4,7 | 26 | 6,5 | 9 | 4,4 | 8 | 4,3 | 72 | 5,1 |
| Blennius fascigula | 1 | 0,3 | 2 | 0,7 | | | | | 1 | 0,5 | 4 | 0,3 |
| Chaladoderma capito | | | 1 | 0,3 | | | | | | | 1 | 0,07 |
| Palunolepis brachydactylus | 1 | 0,3 | 2 | 0,7 | 3 | 0,8 | 6 | 2,9 | 3 | 1,6 | 15 | 1,1 |
| Palunolepis grandis | | | 3 | 1,0 | | | | | | | 3 | 0,2 |
| Cheilodactylus fasciatus | | | 4 | 1,4 | 3 | 0,8 | 2 | 1,0 | 2 | 1,1 | 11 | 0,8 |
| Acanthistius sebastoides | 1 | 0,3 | 2 | 0,7 | 1 | 0,3 | 1 | 0,5 | | 5 | 5 | 0,4 |
| Epinephelus guaza | 1 | 0,3 | 1 | 0,3 | | | | | | | 2 | 0,1 |
| Halidesmus scapularis | 1 | 0,3 | | | | | | | | | 1 | 0,07 |
| Leptocephalus | | | 1 | 0,3 | | | | | | | 1 | 0,07 |
| Tachysurus fossor | | | | | 14 | 3,5 | | | | | 14 | 1,0 |
| Heteromycteris capensis | | | | | | | 1 | 0,5 | | | 1 | 0,07 |
| Diplodus sargus | | | 7 | 2,4 | | | | | 2 | 1,1 | 9 | 0,6 |
| Sparodon durbanensis | | | 3 | 1,0 | 1 | 0,3 | 3 | 1,5 | | | 7 | 0,5 |
| Sarpa salpa | | | | | | | 3 | 1,5 | | | 3 | 0,2 |
| Gobius nudiceps | | | | | | | | | 1 | 0,5 | 1 | 0,07 |
| Total fish | 234 | 74,5 | 199 | 67,2 | 288 | 72,0 | 111 | 54,2 | 143 | 76,5 | 975 | 69,3 |
| TOTAL | 315 | | 296 | | 402 | | 207 | | 187 | | 1407 | |

TABLE 7

Animals collected with rotenone in Area 3 (Tidal gully).

| Species | 10 June 1977 | | 13 October 1977 | | Total | |
|---|---|---|---|---|---|---|
| | no. | % | no. | % | no. | % |
| Plagusia chabrus | 5 | 5,3 | 9 | 10,1 | 14 | 7,7 |
| Cyclogropsus punctatus | 2 | 2,1 | 3 | 3,4 | 5 | 2,7 |
| Ovalipes sp. | 2 | 2,1 | | | 2 | 1,1 |
| Octopus granulatus | 1 | 1,1 | 2 | 2,2 | 3 | 1,6 |
| Clinus cottoides | 1 | 1,1 | 1 | 1,1 | 2 | 1,1 |
| Clinus superciliosus | 4 | 4,2 | 36 | 40,4 | 40 | 21,9 |
| Clinus anguillaris | 1 | 1,1 | | | 1 | 0,5 |
| Chorisochismus dentex | 2 | 2,1 | | | 2 | 1,1 |
| Blennius cornutus | 1 | 1,1 | 1 | 1,1 | 2 | 1,1 |
| Blennius fascigula | 11 | 11,7 | | | 11 | 6,0 |
| Palunolepis brachydactylus | 1 | 1,1 | 5 | | 6 | 3,3 |
| Palunolepis grandis (?) | | | 1 | 1,1 | 1 | 0,5 |
| Acanthistius sebastoides | 1 | 1,1 | | | 1 | 0,5 |
| Epinephelus guaza | 2 | 2,1 | | | 2 | 1,1 |
| Epinephelus andersoni | 1 | 1,1 | | | 1 | 0,5 |
| Gobius nudiceps | 21 | 22,3 | 7 | 7,9 | 28 | 15,3 |
| Diplodus sargus | 9 | 9,6 | 14 | 15,7 | 23 | 12,6 |
| Diplodus trifasciatus | | | 2 | 2,2 | 2 | 1,1 |
| Sparodon durbanensis | 17 | 18,1 | 3 | 3,4 | 20 | 10,9 |
| Liza richardsoni | 10 | 10,6 | | | 10 | 5,5 |
| Conger conger | 1 | 1,1 | | | 1 | 0,5 |
| Leptocephalus | | | 2 | 2,2 | 2 | 1,1 |
| Unidentified fish | 1 | 1,1 | 3 | 3,4 | 4 | 2,2 |
| Total Fish | 84 | 89,1 | 75 | 84,3 | 159 | 86,9 |
| Total | 94 | | 89 | | 183 | |

TABLE 8

Percentage frequency of items recorded in otter spraints during the study period

| Item | 1977 J | F | M | A | M | J | J | A | S | O | N | D | 1978 J | F | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plagusia chabrus | 92,6 | 94,5 | 90,0 | 91,2 | 91,8 | 92,5 | 97,2 | 94 | 93,0 | 96,4 | 95,6 | 95,9 | 86 | 98 | 90,9 |
| Cyclograpsus punctatus | 25,7 | 29,4 | 37,4 | 52,6 | 54,1 | 37,4 | 19,8 | 24 | 33,3 | 36,4 | 44,4 | 32,7 | 40 | 44 | 50,0 |
| Jasus lalandii | 9,5 | 1,0 | | | 5,1 | 1,9 | 0,9 | 2 | | | | | 2 | | |
| Potamon perlatus | 2,7 | 2,5 | | 1,8 | | 0,9 | | | 1,8 | 3,6 | 4,4 | 12,2 | 10 | 6 | 4,5 |
| Other Crustacea | | | | 1,8 | | | | | | | 6,6 | 2,0 | 4 | | |
| Octopus granulatus | 16,2 | 17,9 | 26,3 | 14,0 | 24,5 | 33,6 | 28,3 | 42 | 45,6 | 30,9 | 33,3 | 18,4 | 16 | | |
| Sepia tuberculata | | | | 1,8 | | 00,9 | | 2 | | | | | | | |
| Chorisochismus dentex | 63,5 | 46,3 | 46,5 | 32,5 | 51,0 | 55,1 | 67,9 | 82 | 66,7 | 50,9 | 75,6 | 65,3 | 66 | 68 | 54,5 |
| Apletodon knysnaensis | | | | | | | | | | | | 2,0 | | | |
| Clinus cottoides | | | | | | 36,4 | 25,5 | 48 | 28,1 | 36,4 | 53,3 | 30,6 | 34 | 44 | 13,6 |
| Clinus superciliosus | | | | | | 10,3 | 10,4 | 14 | 12,3 | 5,5 | 17,8 | 12,2 | 4 | 4 | 13,6 |
| Clinus capensis | 2,0 | 2,0 | 5,1 | 7,0 | 13,3 | 6,5 | 0,9 | 4 | 7,0 | 5,5 | 8,9 | 6,1 | 6 | 8 | 4,5 |
| Clinus anguillaris | | | | | | | | 2 | | | | | 2 | 2 | 4,5 |
| Clinus taurus | | | | | | | | | | | | 4,1 | | | |
| Pavoclinus graminis | | | | | | 3,7 | 4,7 | 8 | 10,5 | 9,1 | 8,9 | 8,2 | 10 | 10 | 9,1 |
| Pavoclinus pavo | | | | | | | | 2 | 1,8 | | 2,2 | | 2 | 4 | |
| Unidentified Clinidae | 36,5 | 47,3 | 47,5 | 50,0 | 42,9 | 7,5 | 4,7 | 10 | 3,5 | 3,6 | 6,7 | 12,2 | 16 | 8 | 13,6 |
| Blennius cornutus | 12,8 | 17,4 | 22,2 | 24,6 | 27,6 | 25,2 | 15,1 | 50 | 26,3 | 18,2 | 48,9 | 24,5 | 24 | 44 | 22,7 |
| Blennius fascigula | | | | 0,9 | | 3,7 | 1,9 | 2 | 3,5 | | | 2,0 | | 2 | |
| Gobius nudiceps | 4,1 | 3,0 | 6,1 | 12,3 | 4,1 | 14,0 | 7,5 | 10 | 12,3 | 7,3 | 6,7 | 2,0 | 10 | 6 | 4,5 |
| Acanthistius sebastoides | 1,4 | 1,0 | 1,0 | 1,8 | 4,1 | 3,7 | 3,8 | 6 | 5,3 | | 6,7 | 4,1 | 6 | 6 | |
| Epinephelus guaza | | | | | | 1,9 | 0,9 | 4 | | | 2,2 | 2,0 | | | |
| Epinephelus andersoni | | | | | | | | | | 1,8 | | | | | |
| Unidentified Serranidae | 1,4 | 1,0 | 1,0 | | 1,0 | 2,8 | | 2 | 3,5 | | 2,2 | 2,0 | | | 4,5 |
| Palundepis brachydactylus | 3,4 | 3,0 | 4,0 | 5,3 | 9,2 | 6,5 | 0,9 | 14 | 7,0 | 16,4 | 17,8 | 6,1 | 14 | 12 | 9,1 |
| Cheilodactylus fasciatus | | 0,5 | 1,0 | 3,5 | 2,0 | 4,7 | 0,9 | 2 | 8,8 | 10,9 | 4,4 | 6,1 | 12 | 2 | |
| Diplodus sargus | | 0,5 | 3,0 | 2,6 | 4,1 | 7,5 | 3,8 | 6 | | | 17,8 | 6,1 | 12 | 18 | 4,5 |
| Sparodon durbanensis | | 0,5 | 3,0 | 0,9 | | 0,9 | 0,9 | | | | 2,2 | | 4 | | 4,5 |
| Rhabdosargus tricuspidens | 0,7 | | | | | 0,9 | 3,8 | | 1,8 | | 6,7 | 2,0 | | 2 | |
| Lithognathus mormyrus | | | | 1,8 | | 0,9 | | | | | 2,2 | | | | |
| Sarpa salpa | 0,7 | 1,0 | | | 1,0 | | | | | 3,6 | | | 6 | 10 | 4,5 |
| Boopsoidea inornata | | | | | | 0,9 | 0,9 | | | | | 4,1 | | | |
| Spondyliosoma emarginatum | 0,7 | | | | 1,0 | | | | | | | | | | |
| Pagellus natalensis | 0,7 | | | | | | | | | | | | | 2 | |
| Unidentified Sparidae | 0,7 | 1,5 | 1,0 | 1,8 | | 1,9 | 3,8 | 4 | | 1,8 | | 4,1 | 8 | 2 | 9,1 |
| Pomadasys olivaceus | | | | | | | | | | | 44 | | 2 | | |
| Liza richardsoni (?) | | 0,5 | | 0,9 | | 4,7 | 2,8 | 2 | 3,5 | 1,8 | | | | | |
| Unidentified Pisces | 14,9 | 6,0 | 15,2 | 10,5 | 16,3 | 10,3 | | 6 | 3,5 | 12,7 | 2,2 | 6,1 | 10 | 4 | 9,1 |
| Anura | | | | | | | | | 3,5 | 1,8 | 2,2 | 8,2 | 2 | | |
| Water beetle | 0,7 | | 1,0 | | | | | | 1,8 | | | 6,1 | | | |
| Pill millipede | | 1,0 | | | | | | | | | | | | | |
| Unidentified | 1,4 | | | 0,9 | | | | | 3,5 | 1,8 | | 2,0 | | | |
| Shelled Mollusca | 22,3 | 6,5 | 9,1 | 3,5+ | 9,2 | 14,0 | 21,7 | 42 | 24,6 | 23,6 | 24,4 | 22,4 | 26 | 24 | 18,2 |
| Fish scales | 4,1 | 6,0 | 9,1 | 29,8 | 12,2 | 5,6 | 4,7 | | 3,5 | 5,5 | 11,1 | 8,2 | | 6 | 4,5 |
| Number of spraints | 148 | 201 | 99 | 114 | 98 | 107 | 106 | 50 | 57 | 55 | 45 | 49 | 50 | 50 | 22 |

TABLE 9

Percentage weight of items recorded in otter spraints during the study period

| Item | 1977 | | | | | | | | | | | | 1978 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M |
| Plagusia chabrus | 66,6 | 76,8 | 67,0 | 66,7 | 67,5 | 66,1 | 90,7 | 66,4 | 74,4 | 82,5 | 83,9 | 70,5 | 72,9 | 69,6 | 57,2 |
| Cyclograpsus punctatus | 12,2 | 15,2 | 17,7 | 25,4 | 15,3 | 14,8 | 1,9 | 1,9 | 13,8 | 6,0 | 2,7 | 8,2 | 14,7 | 19,9 | 13,5 |
| Jasus lalandii | 5,0 | 0,1 | | | 1,2 | 1,5 | | 2,5 | | | | | 1,9 | | |
| Potamon perlatus | | 0,1 | | | | | | | 0,1 | 0,4 | 0,1 | 3,1 | 0,1 | 0,2 | 0,4 |
| Other Crustacea | | | | | | | | | 0,1 | | | | | | |
| Chorisochismus dentex | 12,0 | 4,7 | 5,4 | 2,8 | 6,1 | 6,0 | 3,2 | 18,5 | 8,0 | 2,1 | 3,4 | 6,8 | 5,3 | 3,2 | 12,8 |
| Apletodon knysnaensis | | | | | | | | | | | | | | | |
| Clinus cottoides | | | | | | 0,8 | 0,6 | 0,7 | 0,3 | 0,3 | 0,6 | 0,2 | 0,8 | 1,3 | |
| Clinus superciliosus | | | | | 0,1 | 0,2 | 0,2 | 0,1 | 0,2 | | 1,8 | 0,5 | 0,1 | 0,1 | 0,3 |
| Clinus capensis | | | | 0,1 | 0,1 | 0,5 | | | 0,1 | | 0,1 | 0,5 | 0,1 | | 1,6 |
| Clinus taurus | | | | | | | | | | | | 0,1 | | | |
| Pavoclinus graminis | | | | | | | 0,1 | 0,1 | 0,1 | | 0,1 | | 0,2 | 0,1 | |
| Unidentified Clinidae | 0,7 | 0,8 | 0,7 | 1,5 | 1,7 | 0,2 | | | | | 0,1 | | | | |
| Blennius cornutus | 0,1 | 0,1 | 0,2 | 0,9 | 1,1 | 0,4 | 0,3 | 0,6 | 0,2 | 0,1 | 0,5 | 1,1 | 0,2 | 0,6 | 0,1 |
| Gobius nudiceps | | | 0,2 | 0,3 | | 0,2 | 0,1 | 0,1 | 0,2 | 0,1 | 0,1 | | | | |
| Acanthistius sebastoides | 1,0 | 0,5 | | | 0,4 | 1,1 | 0,7 | 0,9 | 0,1 | | 0,1 | 0,4 | 0,6 | 0,3 | |
| Epinephelus guaza | | | | | | 1,4 | | 3,7 | | | 0,1 | | | | |
| Epinephelus andersoni | | | | | | | | | | 0,3 | | | | | |
| Unidentified Serranidae | 0,8 | 0,6 | 1,0 | | 0,3 | 1,4 | 0,4 | 0,7 | | | 0,1 | 0,1 | | | 3,4 |
| Palunolepis brachydactylus | 0,4 | 0,2 | 0,7 | 0,3 | 0,8 | 0,7 | | 1,9 | | 0,2 | 0,5 | 0,1 | 0,2 | 1,7 | 1,1 |
| Cheilodactylus fasciatus | | | 0,1 | | 0,1 | 0,1 | | | 0,1 | | 0,8 | 0,3 | | | |
| Diplodus sargus | | | 0,2 | 0,1 | 0,2 | 0,3 | | 0,2 | | | 2,2 | 1,1 | 0,3 | 1,4 | 0,1 |
| Sparodon durbanensis | | | 0,2 | 0,1 | | | | 0,1 | | | 0,6 | | 0,2 | | |
| Rhabdosargus tricuspidens | 0,1 | | | | | 0,2 | 0,4 | | | | 0,1 | 0,1 | | 0,1 | |
| Lithognathus mormyrus | | | | 0,4 | | | | | | | 0,2 | | | | |
| Sarpa salpa | | | | | | 0,5 | | | | 0,7 | | | 0,9 | 0,9 | |
| Spondyliosoma emarginatum | | | | | 0,1 | | | | | | | | | | |
| Unidentified Sparidae | | 0,2 | | 0,2 | | | 0,1 | | | | | 1,8 | | | 2,3 |
| Pomadasys olivaceus | | | | | | | | | | | 0,4 | | | | |
| Liza richardsoni (?) | | | | | | 1,6 | | | 0,2 | | | | | | |
| Unidentified fish | 0,4 | 0,5 | 5,5 | 0,5 | 4,4 | 0,9 | 0,6 | 0,1 | 1,3 | 6,4 | 0,7 | 1,8 | 0,7 | | 5,4 |
| Anura | | | | | | | | | | 0,2 | 0,2 | 0,8 | | | |
| Unidentified | | | 0,9 | | | | | | 0,1 | | | | | | |
| Mollusca (shelled) | 0,3 | 0,1 | 0,1 | 0,5 | 0,4 | 0,7 | 0,5 | 1,2 | | 0,4 | 0,5 | 0,4 | 0,8 | 0,5 | 1,4 |
| Scales | 0,3 | 0,1 | | | | 0,2 | | | | | | | | | |
| Total weight | 1922,9 | 1954,0 | 748,2 | 918,1 | 856,9 | 1020,2 | 1198,2 | 484,8 | 621,3 | 740,7 | 789,5 | 534,7 | 739,5 | 805,3 | 286,5 |

PREY ANIMALS

Phylum Arthropoda

Class Crustacea

| | |
|---|---|
| Subclass | Malacostraca |
| Order | Decapoda |
| Suborder | Reptantia |
| Section | Brachyura |
| Superfamily | Brachyrhyncha |
| Family | Grapsidae |

*Plagusia chabrus* (Linnaeus)

The first impression one gets when looking at an old otter latrine, is that of a mass of crab shells, mostly of *Plagusia chabrus*, the common red rock crab. My first conclusion was that, like the Cape clawless otters inland, the otters of Tsitsikama subsist almost exclusively on crabs. However, analysis proved this was not so, but according to the most accurate estimate (see end of chapter), they still form 42% of the otters' food (36% of biomass) (Table 16).

The shells of *Plagusia* are easily identified and distinguished from those of the only other crab species present in the diet of otters, *Cyclograpsus punctatus*.

Chelae were selected as an index of size of crabs. The two measurements that were taken were (1) the length of the whole chela, and (2) the length of the "finger" only. The thick parts of the chelae were frequently broken, but a large number of fingers were intact.

A complicating factor was the sexual dimorphism that exists between the sizes and forms of chelae. Up to a carapace width of about 40 mm, dimorphism is very limited, but in crabs larger than this it becomes more and more marked (Figure 9). Males have short and thick chelae and fingers, whereas the chelae and fingers of females are relatively long and thin. A solution was found by quantifying these forms as a ratio between the length and height of a chela/finger. This ratio was always higher than 2,8 : 1 in the case of chelae of females and lower than 2,8 : 1 in the case of males. For fingers

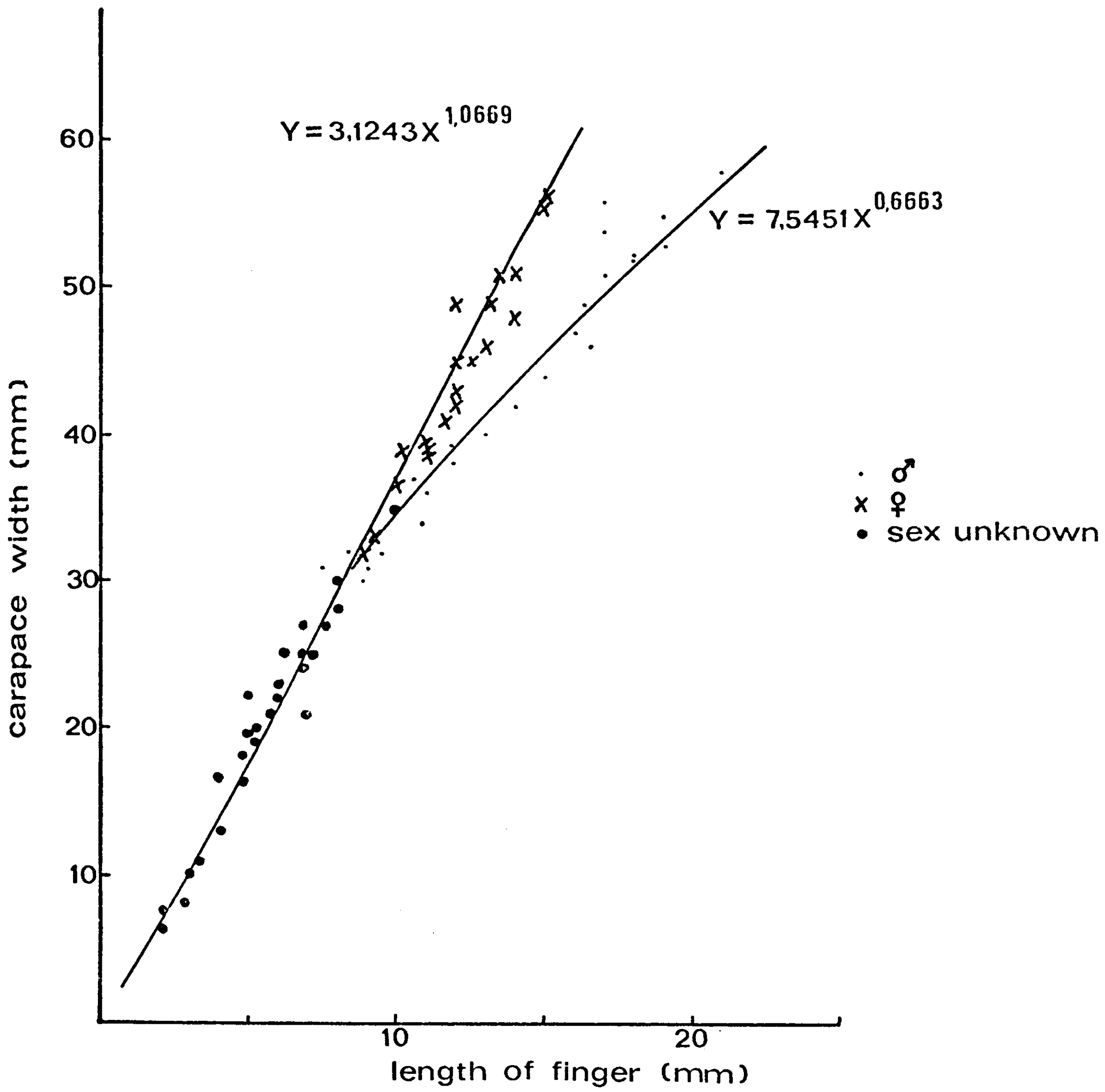



Fig. 9 Length of finger as estimator of carapace width of <u>Plagusia chabrus</u>.

the dividing ratio was 2,65 : 1. The ratios very seldom approached these dividing ratios, and distinction was therefore easy.

Sexual dimorphism was not of any great practical importance, as the average size of individuals taken was estimated at about 29,5 mm. If only one regression was used for males as well as females, it would have made very little difference (computed to be a maximum of 1,5 mm on average monthly size).

Four regressions were computed as follows :

| | | | S.E. |
|---|---|---|---|
| Female | Carapace : Chela | $Y = 1,4583\ X^{1,0918}$ | 0,029 |
| | Carapace : Finger | $Y = 3,1243\ X^{1,6669}$ | 0,026 |
| Male | Carapace : Chela | $Y = 1,938\ X^{0,966}$ | 0,030 |
| | Carapace : Finger | $Y = 7,5457\ X^{0,6663}$ | 0,031 |

where X = chela/finger length, and Y = carapace width.

Statistical details of these equations can be found in Appendix 1.

During the first few months the heights of chelae and fingers were not measured and the sexes of the crabs could therefore not be determined. In these cases, where finger length was 10 mm or more, the sizes were estimated from the female as well as male formulas and frequency distribution and average size for both determined monthly. The averages of the two were then used. Where the finger length was less than 10 mm, only the female formula was used. The results obtained this way do not differ significantly from later results where sex was known ($p < 0,005$).

Figure 10 illustrates monthly variation in the importance of Plagusia.

Percentage frequency of remains in spraints varies very little, and is mostly more than 90%. This certainly indicates that Plagusia is an important sustaining food. Relative percentage frequency varies somewhat more, this of course being the result of the influence of other prey items. This method is probably more indicative of the real importance of crabs, as can be illustrated by a hypothetical example.

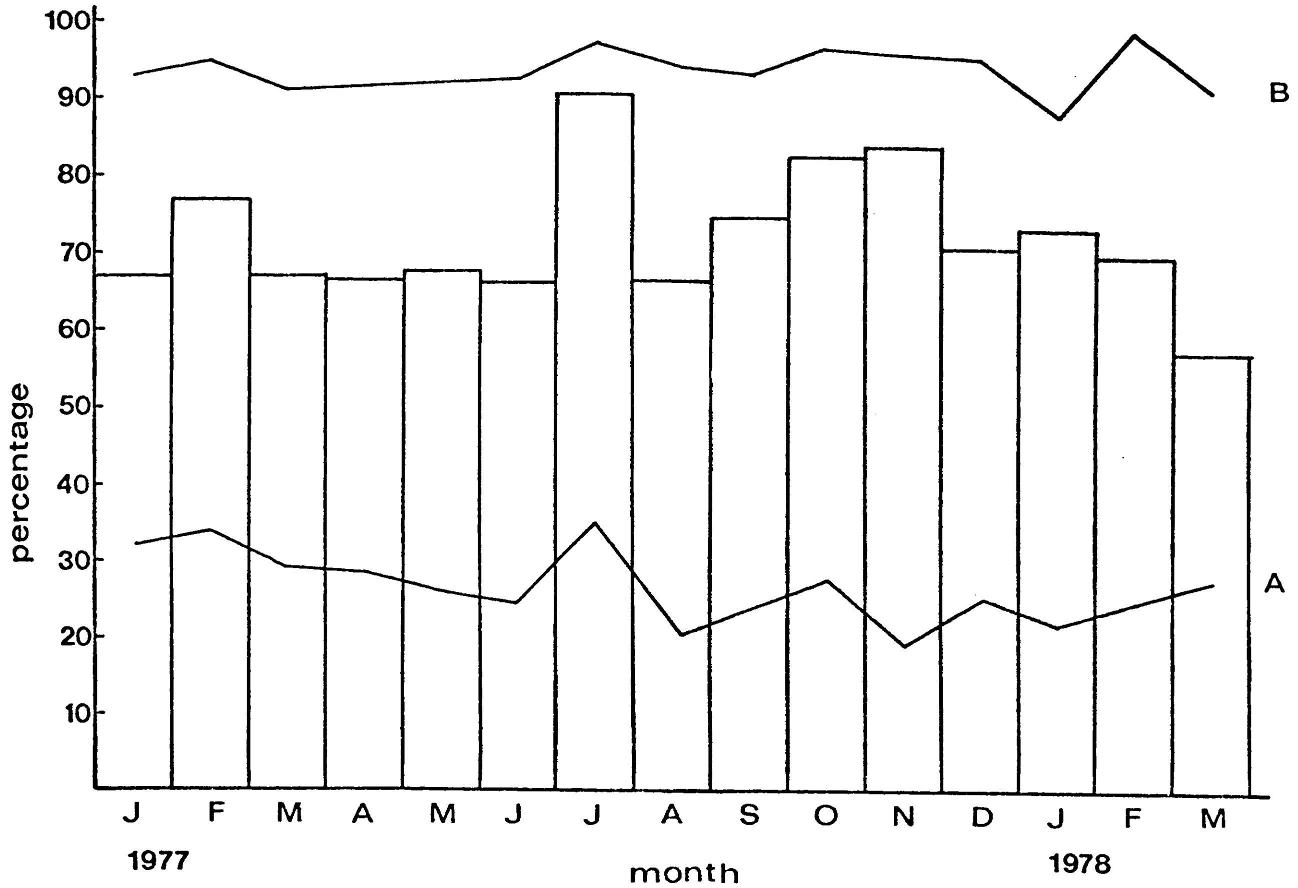



Fig. 10 Plagusia chabrus : Monthly variation in % weight (histogram), relative % frequency (A), and % frequency (B) of remains in spraints.

If ten spraints contain only remains of Plagusia, percentage frequency as well as relative percentage frequency would be 100%. If another ten spraints all contain remains of Plagusia too, but in addition each one contains the remains of a species of fish and octopus, the picture changes. In this case percentage frequency is still 100%, but relative percentage frequency is now only 33,3% ($\frac{10}{30} \times 100$), obviously a more accurate indication of the importance of Plagusia. The most accurate indication of importance is probably that of percentage weight. In the example mentioned previously, the spraints of the second group may each contain the remains of one crab or several crabs. It would make no difference to percentage frequency or relative percentage frequency, but remains of more crabs per spraint are likely to contribute more to the total weight of the spraints.

The monthly variation is difficult to interpret. A large peak in percentage weight in July, and a lesser peak in February 1977 correspond with similar peaks in relative percentage frequency. On the whole, however, correlation between the two methods is not good. A correlation coefficient of 0,165 was computed. Correlation between percentage weight and percentage frequency was better ($R = 0,57$; $p < 0,025$). No variation in any of the three methods was significant when $\chi^2$ was computed ($p > 0,05$). When relative percentage frequency was correlated with average monthly sea temperature, a correlation coefficient of 0,35 ($p > 0,05$) was obtained. Correlation of percentage weight with the average of selected sea temperatures only of the days that spraints were actually collected yielded a coefficient of -0,13 ($p > 0,05$). Correlation is obviously not good, and especially the two peaks of February and July are not reflected in average sea temperature. Sea temperature apparently has no, or very little influence on the number of crabs caught by otters.

Another hypothesis explaining monthly fluctuation was that the actual availability of crabs might vary between seasons. This could be tested with the results of the samplings with rotenone. Altogether ten samplings were made in two different areas, as explained before.

Data from Area 2 do not seem to explain variation in the diet, the main discrepancy being the peak in March (Figure 11). Percentage weight in March is low. In Area 1 however, there is a definite drop

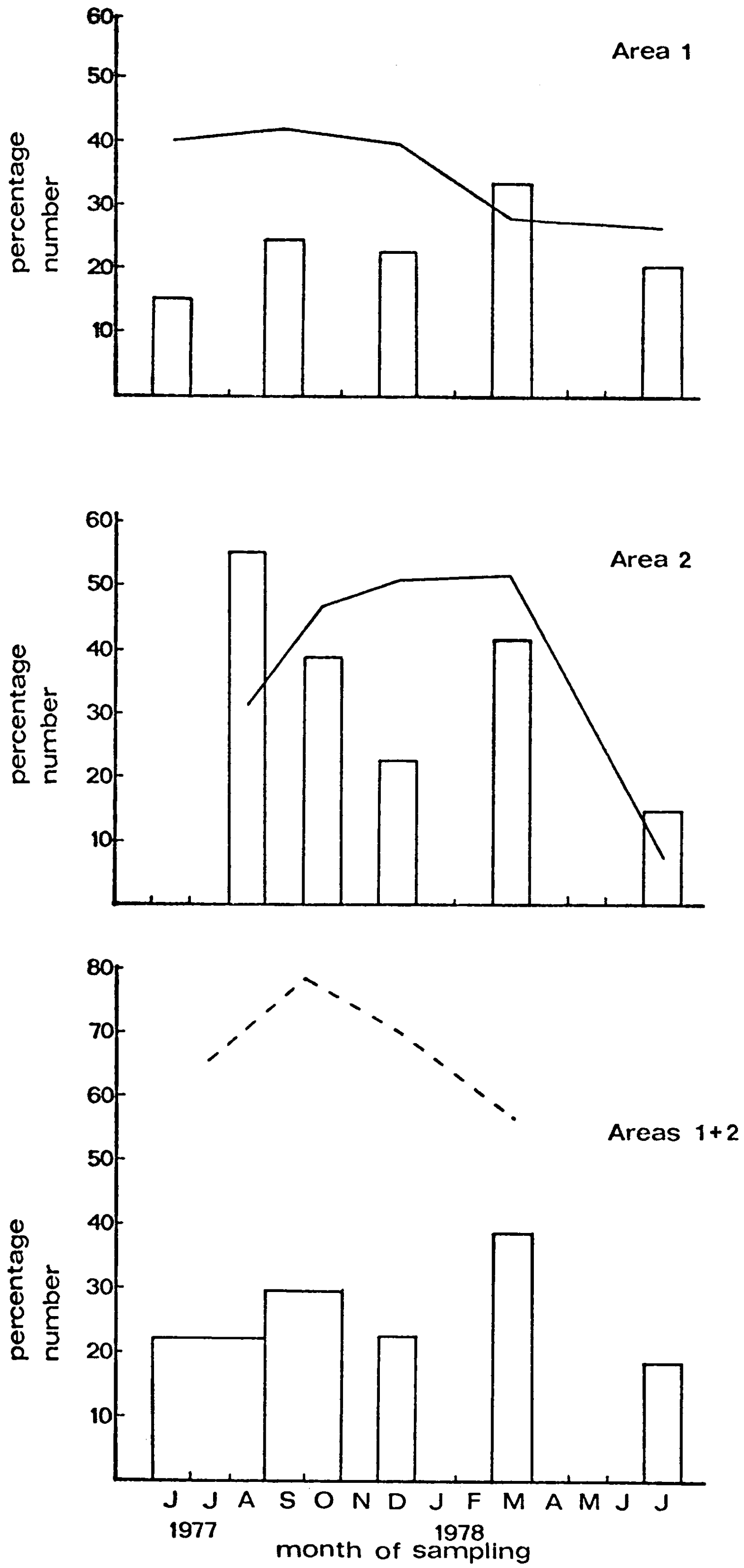



Fig. 11 Frequency distribution of Plagusia chabrus from samplings with rotenone in two different areas June 1977 to July 1978, and percentage weight of remains in spraints of the months of sampling. Data for Areas 1 and 2 combined in last diagram.

Histogram : percentage frequency

——— actual number collected

- - - - - Percentage weight of remains in spraints in actual number collected. The rise in percentage of the total catch is the result of a lower proportion of other organisms. When the combined data of Areas 1 and 2 are used (Figure 11), correlation appears good up to December 1977, but once again the peak in March does not reflect the drop in percentage weight.

The actual number of Plagusia collected in Area 1 correlates very well with percentage weight in spraints ($R = 0,94$; $p < 0,05$). Correlation of percentage of the total catch is not so good ($R = 0,54$; $p < 0,1$), due to the data for March. Correlation of the results of Area 2 with percentage weight in spraints is not good at all (percentage of total catch $R = -0,24$; $p > 0,25$, actual number $R = -0,03$; $p > 0,25$). Results of Area 1 therefore reflect the importance of Plagusia in the diet of otters far better than the results of Area 2.

The data from the two areas could be interpreted as a slight migration of Plagusia towards the sea in March. If the shallower area was the main hunting area of the otter, as suggested by the good correlation, the drop in percentage weight in March would be explained. The use of only two sampling areas in rather imperfectly defined habitat types however, makes this conclusion risky, at least without first examining the situation in other prey animals. Furthermore, the two peaks in July and February 1977 are not explained this way. No apparent explanation, other than sampling error, is available for these two peaks.

Spraints from four different holts were analysed separately to determine the degree of variation between holts (Figure 12). The peaks in July and September to November, as well as the drop in December, appear to be rather general, but there is a lot of variation between holts. This may be the result of differences in microhabitat, but along distances travelled by otters should at least partly cancel this effect. This extreme variation between the spraints of different holts, appears to provide more evidence for the non-significance of seasonal variation in the importance of Plagusia.

A comparison with the results of Rowe-Rowe (1975, 1977a) is not warranted, due to the extreme differences in habitat and faunal composition between fresh water and the sea. What is probably important however,

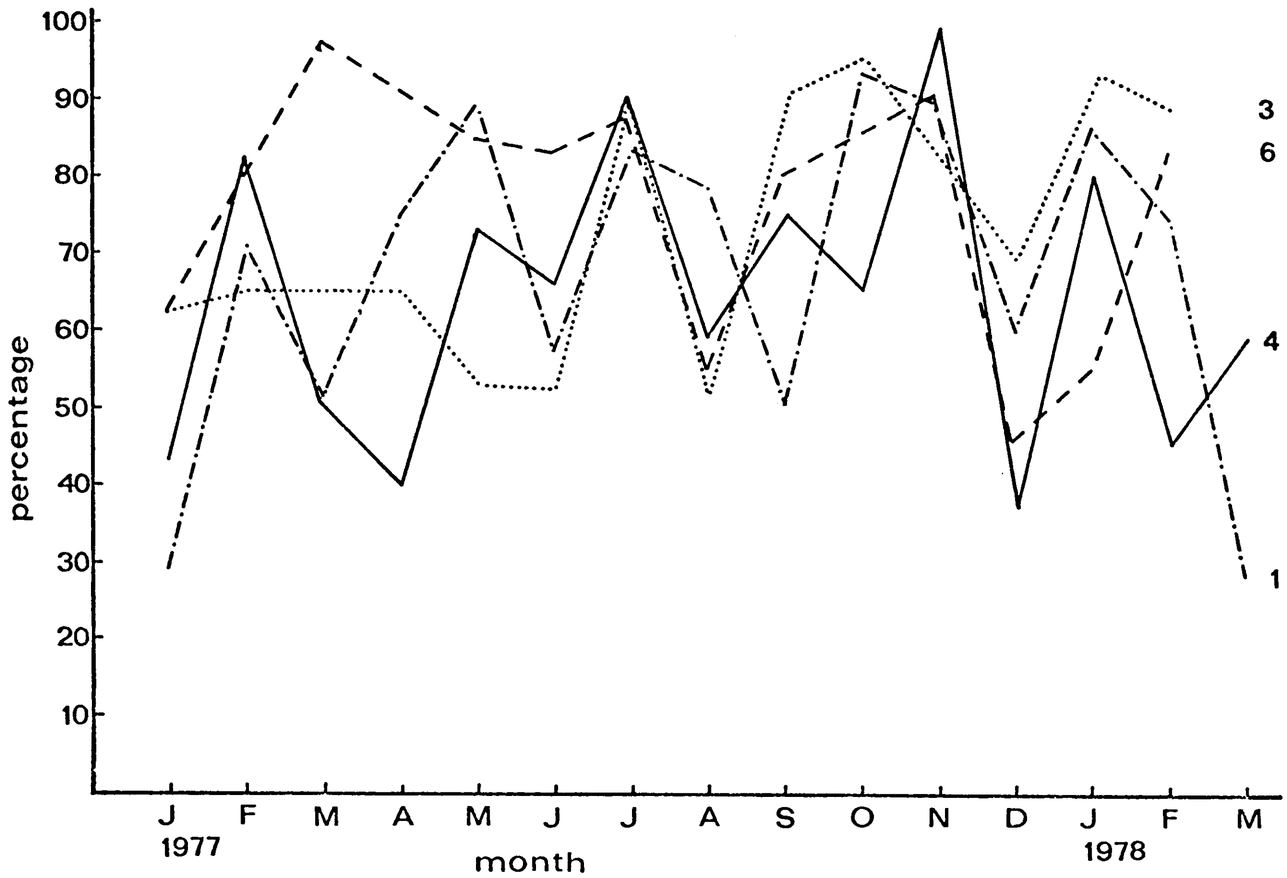



Fig. 12 % Weight of remains of Plagusia chabrus in spraints of four different holts. Holt numbers refer to Fig. 41.

is the importance of crabs as a sustaining food of Aonyx. Using the data of spraint analysis and sampling of Areas 1 and 2 combined, but not taking Cyclograpsus into account, Ivlev's electivity index for this species is +0,4. Despite a wider range of food therefore, Aonyx appears to have retained its preference for crabs.

Seasonal variation in size classes taken by otters as well as by rotenone, appears to be limited (Figures 13 and 14). In all cases a histogram containing all the data of the study period presents a better illustration than the individual monthly sets of data.

Distribution of size classes taken by otters does not differ significantly from a normal distribution ($p < 0,05$), with 76% being from 20 to 35 mm (carapace width). These correspond to weights of 5,2 g to 22,1 g. ($\text{Weight} = 0,0022\ \text{carapace}^{2,593}$). Average carapace width was estimated at 29,5 mm (standard error 6,7 mm), while the estimate of average weight taken was 12,7 g (Figure 15).

When the data of Areas 1 and 2 are combined, a more or less normal distribution also appears to result. Between the two sets of data however, there is a noteworthy difference. Of the crabs collected in Area 1, 63% had a carapace width of less than 30 mm. The corresponding percentage for Area 2 was 38%, which was significantly different ($\chi^2$ : $p < 0,005$). Crabs found to be in berry were always larger than 33 mm, so that this seems to be more or less the size at which sexual maturity is reached. It would appear then, that juveniles tend to concentrate in the shallower, intertidal zone, whereas adults tend to concentrate in the deeper, infratidal areas. The crabs collected the first time in area 3, the tidal gully, were all adults between 34 and 56 mm, while those collected the second time were all juveniles between 8 and 18 mm. The separation of juveniles and adults is therefore no more than a tendency, as very small and very large crabs were found in all areas. The size class apparently preferred by otters, 25 to 29,9 mm, i.e., a class of subadults, was most prevalent in Area 1. Second in preference, 30 to 34,9 mm, or subadults to young adults, was most prevalent in Area 2, whereas the third in preference, 20 to 24,9 mm was again most prevalent in Area 1. Of the crabs taken by otters, 56% were juveniles less than 30 mm, while 44% were 30 mm or more.

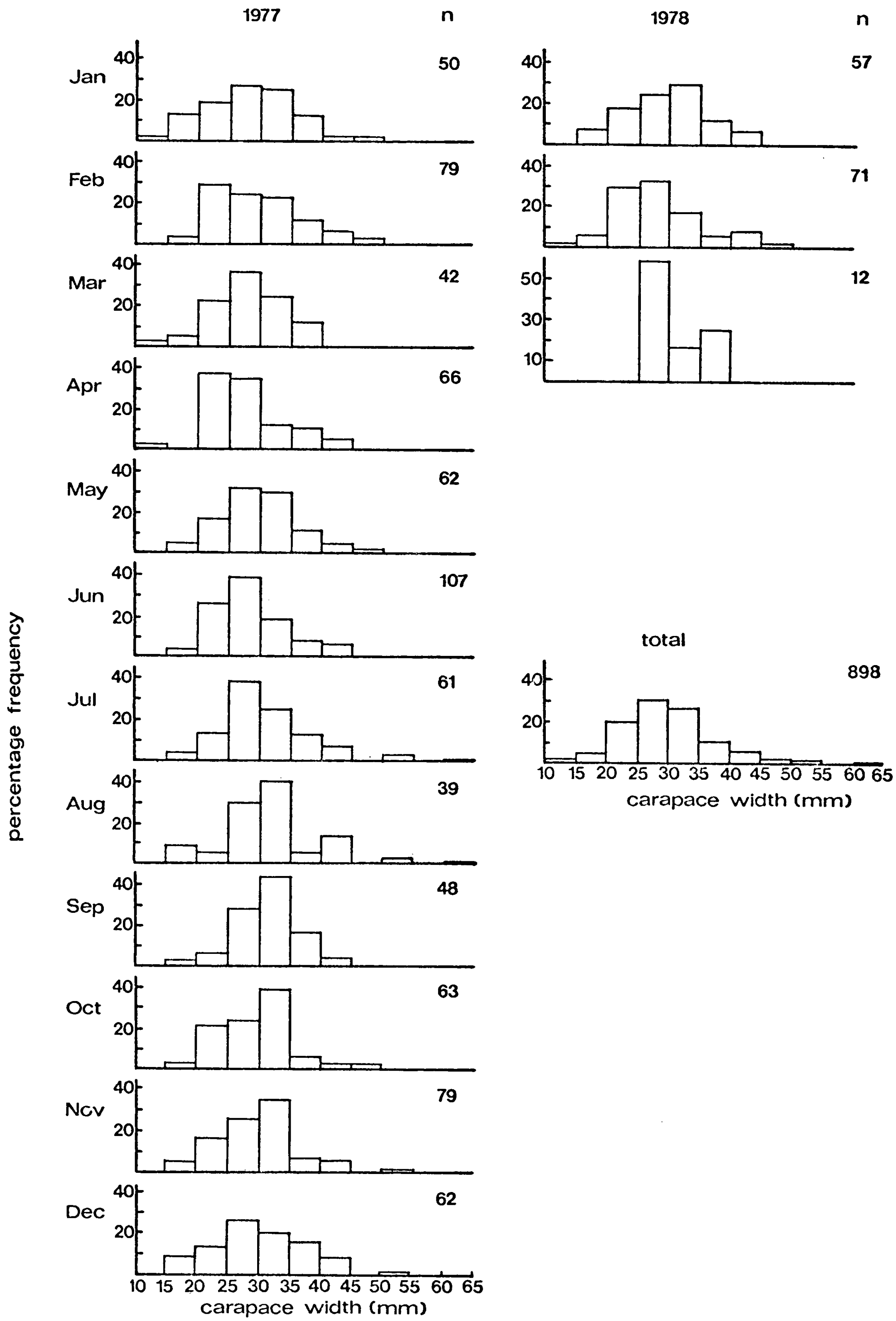



Fig. 13 Size-percentage frequency diagrams of Plagusia chabrus taken by otters January 1977 - March 1978. Estimated from chelae in spraints and at holts.

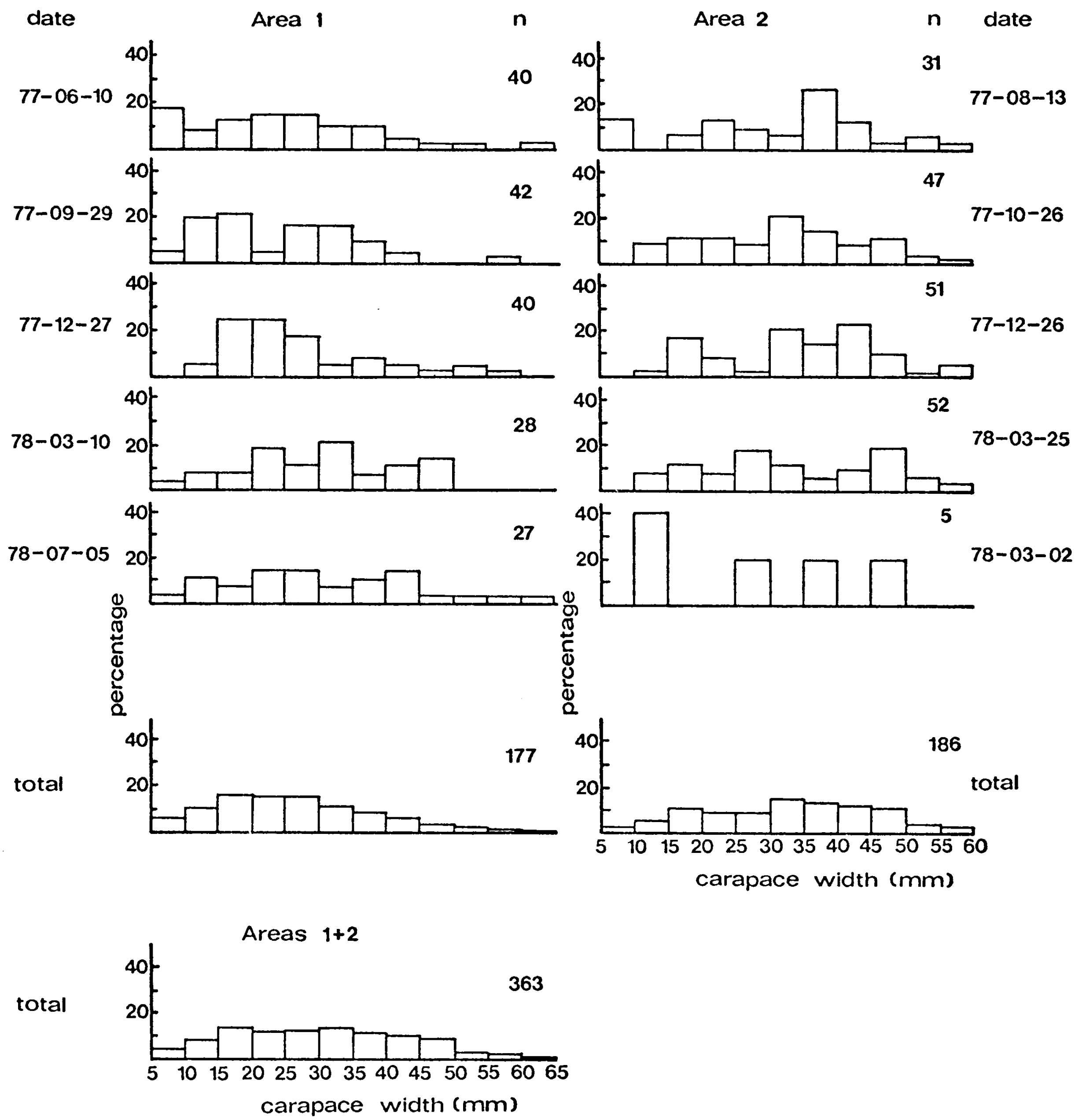



Fig. 14 Frequency distribution of size classes of Plagusia chabrus taken during sampling with rotenone.

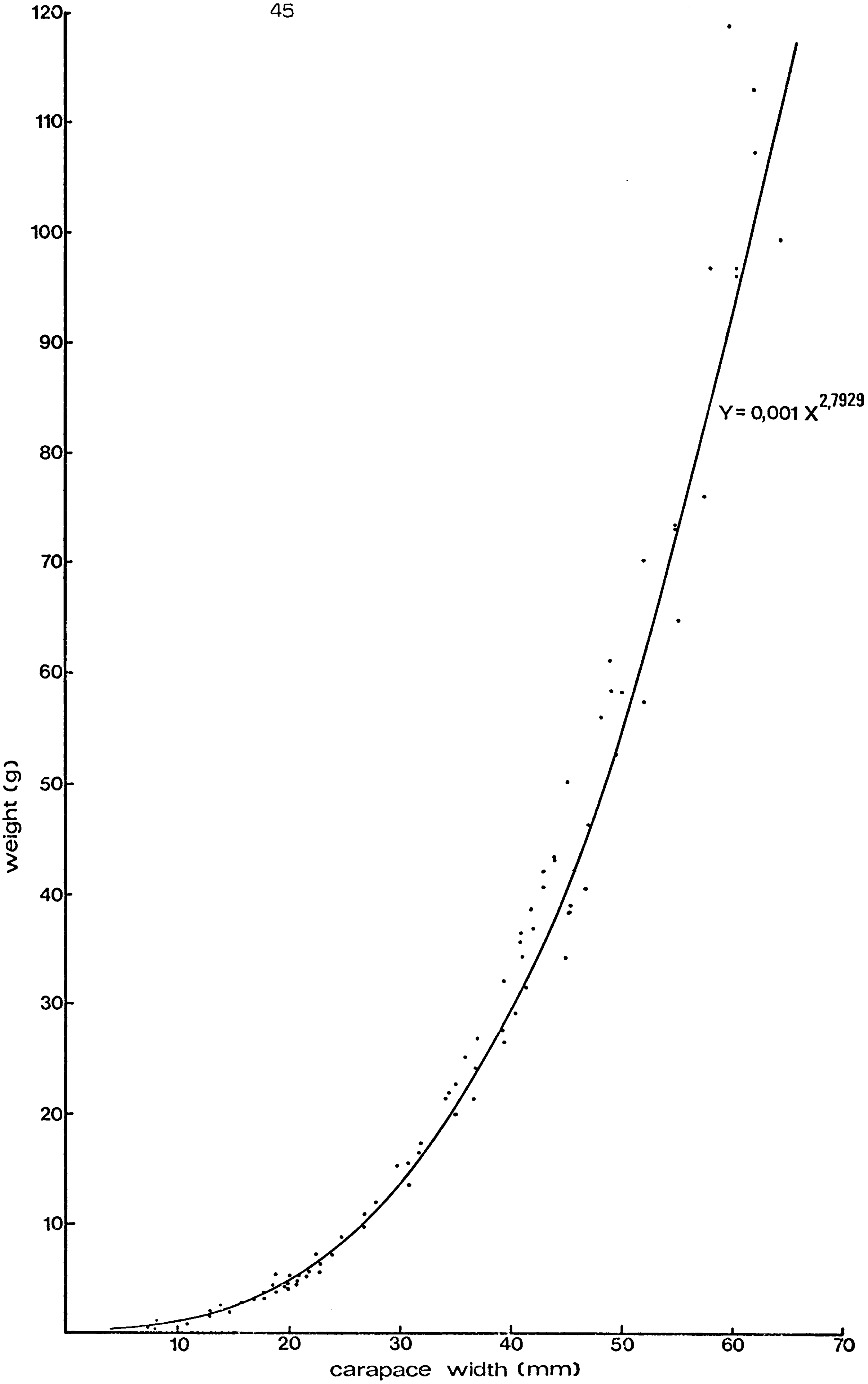



Fig. 15 Carapace width as estimator of weight of Plagusia chabrus.

Again the data indicate the shallower intertidal area as the preferred hunting area of otters.

At this point it should be mentioned that the remains of five large crabs were found at holts during the study period. Their estimated sizes were 46 mm, 55 mm, 55 mm, 61 mm and 64 mm. In two cases (55 mm and 64 mm), the carapace could be measured, while in the other cases the width was estimated from chelae sizes. This indicates that otters do eat large crabs, but very infrequently. Furthermore, it was observed that large crabs were taken to the shore to eat, as in the case of large fish (Fitzsimmons 1919, Rowe-Rowe 1977 b). The remains of three of the crabs consisted of only one (right) chela, of another individual a chela and carapace were found, while in the fifth case a carapace together with both chelae were found. Inclusion of these few large crabs into the data obtained from spraints, as has been done (Figure 13), makes very little difference to the overall pattern.

Selection of specific size classes is apparent (Figure 16). Ivlev's (1961) electivity index was calculated for each of the size classes (Table 10). It appears that crabs of 20 to 35 mm are positively selected, while smaller or larger crabs are negatively selected. Very small crabs are apparently not eaten at all, probably due to the difficulty of catching these. This may also be the reason for the avoidance of crabs of 10 to 20 mm. The avoidance of the larger size classes is not so easy to explain. A simple reason may be that otters risk injury trying to catch large crabs, as these, especially the males, have formidable chelae! Sampling error due to a lack of large chelae in spraints is regarded as unlikely, as all remains of large crabs were rare in spraints. Even after severe crushing, a part of a carapace of a large crab is easy to distinguish from that of a smaller crab.

Otters are very efficient in dealing with crabs, as with other prey, as no spilling was ever observed when eating.

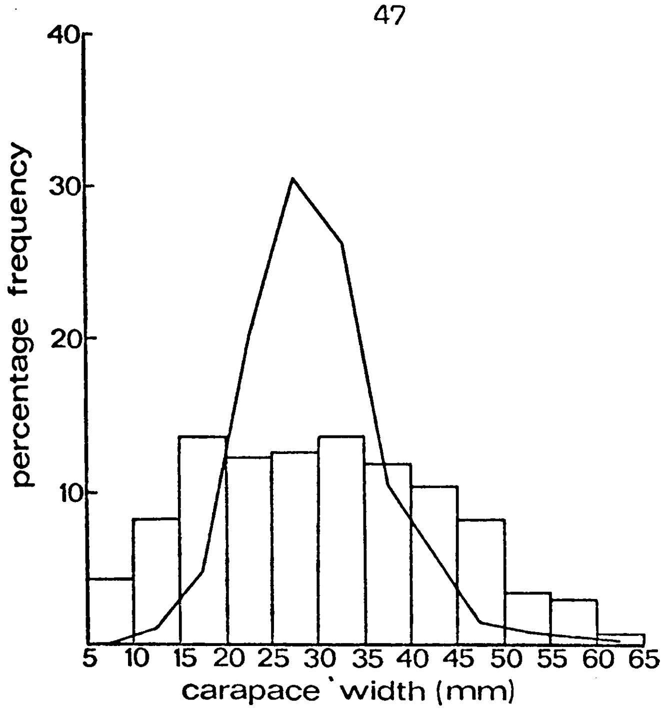



Fig. 16 Frequency of size classes of *Plagusia chabrus* collected with rotenone (histogram) and estimated from chelae in spraints.

TABLE 10

Ivlev's electivity indices (E) for size classes of *Plagusia chabrus*.

| SIZE CLASS (mm) | % TAKEN BY OTTERS | % COLLECTED | E |
|---|---|---|---|
| 5 - 9,9 | 0 | 4,1 | -1,00 |
| 10 - 14,9 | 1,0 | 8,0 | -0,78 |
| 15 - 19,9 | 4,8 | 13,5 | -0,48 |
| 20 - 24,9 | 19,9 | 12,1 | +0,24 |
| 25 - 29,9 | 30,2 | 12,4 | +0,42 |
| 30 - 34,9 | 26,2 | 13,5 | +0,32 |
| 35 - 39,9 | 10,3 | 11,6 | -0,06 |
| 40 - 44,9 | 5,8 | 10,2 | -0,28 |
| 45 - 49,9 | 1,3 | 8,0 | -0,72 |
| 50 - 54,9 | 0,8 | 3,3 | -0,61 |
| 55 - 59,9 | 0 | 2,8 | -1,00 |
| 60 - 65 | 0,2 | 0,6 | -0,50 |

Cyclograpsus punctatus Milne-Edwards

Monthly variation in the importance of the brown rock crab is far more marked than that of Plagusia (Figure 17). A more definite pattern seems to be present too.

Except for a few minor variations, correlation between the three methods of analysis appears to be good. In comparison with the low importance values of July and August, the peaks in April 1977 and February 1978 are highly significant ($p < 0,005$). The seasonal pattern appears to be one of high importance in autumn 1977, dropping to low importance in winter 1977, and then rising again to high importance in late summer 1978. The peak in 1978 appeared to be somewhat earlier than in 1977, but additional data may have indicated a further rise in April to May 1978.

Although the variation is seasonal, it is not directly correlated with sea temperature ($R = 0,35$; $p > 0,1$). Some other factor must be responsible. It is noteworthy that a female (no. 6) which was frequently caught and seen in the main study area had two cubs at the beginning of 1977 and another one at the beginning of 1978. The two cubs were first seen on 21 January 1977. They were sill very young and had probably not yet left the holt. The first time they were observed entering the water together with their mother was on 14 February 1977, after which they were frequently observed until 5 May, when one of the cubs died during a storm at sea. The last traces of the second cub (tracks) were seen on 21 May 1977.

On 14 February 1978 a new cub was seen together with no. 6, hunting between stones in very shallow rock pools. This cub and the female were seen for the last time on 27 March 1978, but they probably still frequented the study area after the end of the study period.

During the first stage of their life after leaving the holt, the young otters apparently spend a great deal of time on land and learn to hunt in very shallow rock pools. As Cyclograpsus is mainly restricted to the Littorina zone and is the most abundant prey animal in this zone, it may be assumed that this crab is heavily preyed upon by young otters and their mothers.

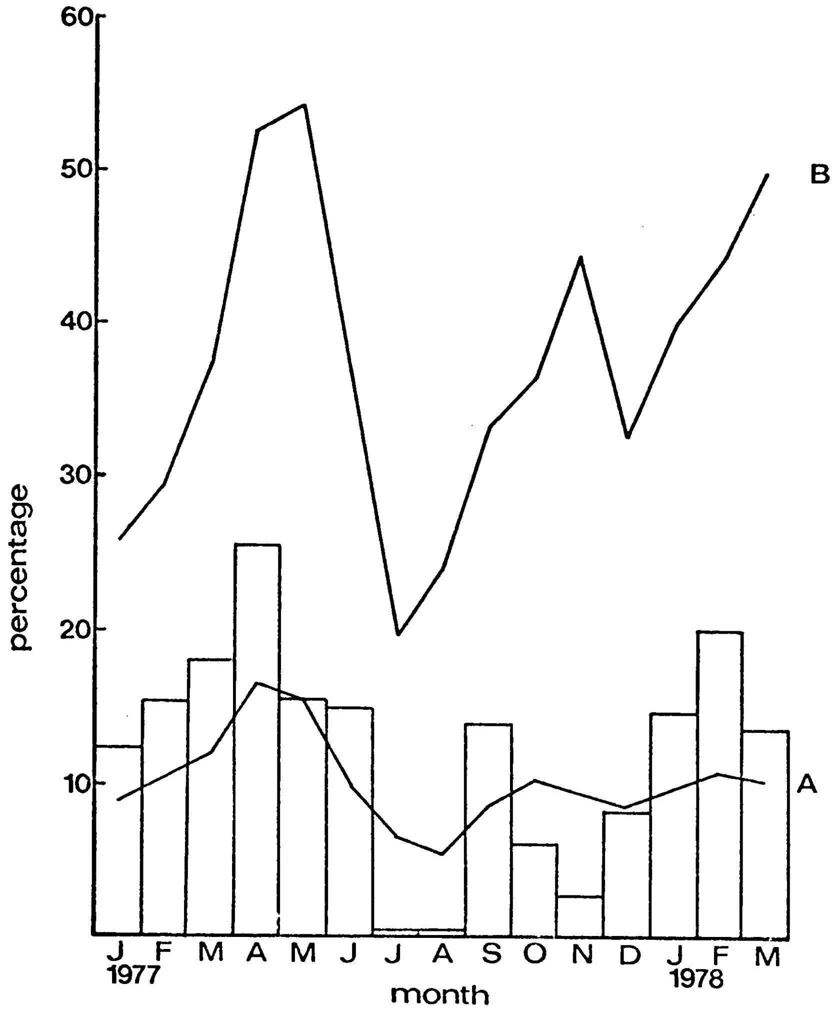



Fig. 17 Cyclograpsus punctatus : Monthly variation in % weight (histogram), relative % frequency (A) and % frequency (B) of remains in spraints during the study period.

It would be presumptuous to attribute all seasonal variation to the behaviour of juvenile otters and their mothers, but the broad correlation between the peaks of activity of juveniles in shallow rock pools and the peaks of importance of Cyclograpsus in spraints appears to be more than a coincidence.

Cyclograpsus was only collected in Area 3, which included the Littorina zone, but even here only five in all were collected. One sampling in a high tide pool was carried out specifically for Cyclograpsus. In this rather small pool (surface area estimated at about 10 $m^2$) 61 crabs were collected. The main aim was to get an idea of sex ratio and frequency distribution of size classes. It was thought unlikely that the monthly variation of Cyclograpsus would be reflected in collections with rotenone. This zone was therefore not sampled on a regular basis.

Chelae were once again used as index of carapace width. Sexual dimorphism was even more marked than in Plagusia (Figure 18). In this case however, no quantification was possible, as the ratio length : height of chelae did not differ between males and females. Sex could therefore not be determined from chelae in spraints. To get some idea of size classes selected, the following method was employed : Male as well as female equations were applied to all chelae and fingers measured in spraints. These were as follows :

| | | | S.E. |
|---|---|---|---|
| Female | Carapace : chela | $Y = 1{,}9337\ X^{0{,}9889}$ | 0,021 |
| | Carapace : finger | $Y = 3{,}2626\ X^{0{,}9891}$ | 0,020 |
| Male | Carapace : chela | $Y = 3{,}911\ X^{0{,}6198}$ | 0,017 |
| | Carapace : finger | $Y = 6{,}2474\ X^{0{,}5617}$ | 0,020 |

where X = chela/finger length and Y = carapace width.

During the sampling with rotenone, and also during subsequent samplings by hand, no females with a carapace of more than 25 mm were found, while carapace width of males ranged up to 30 mm. All values of 26 mm or more after application of the female equation were therefore assumed to be wrong, and the male equation was applied to these measurements. A 1 : 1 sex ratio was assumed (sex ratio of crabs collected with rotenone

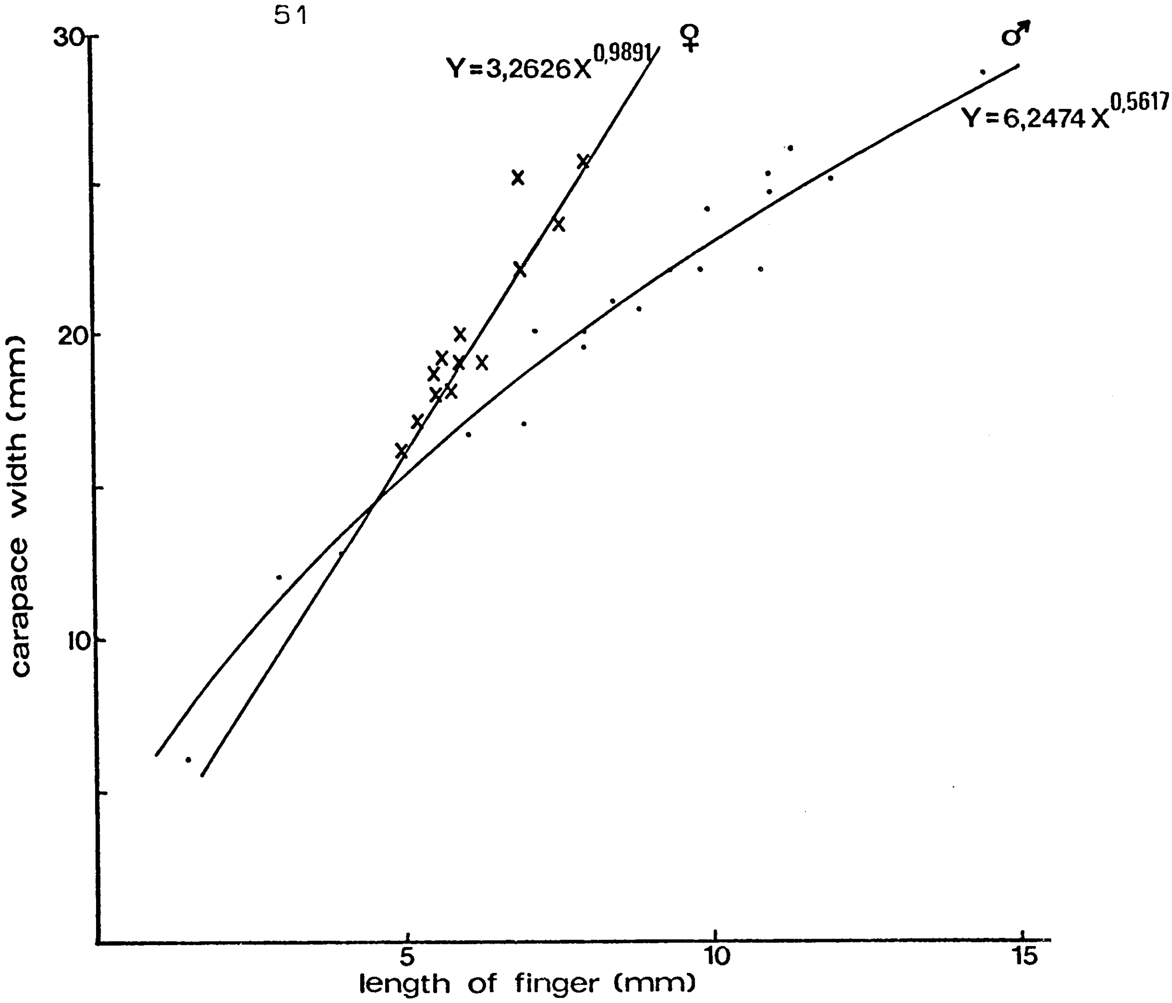



Fig. 18 Length of finger as estimator of carapace width of *Cyclograpsus punctatus*.

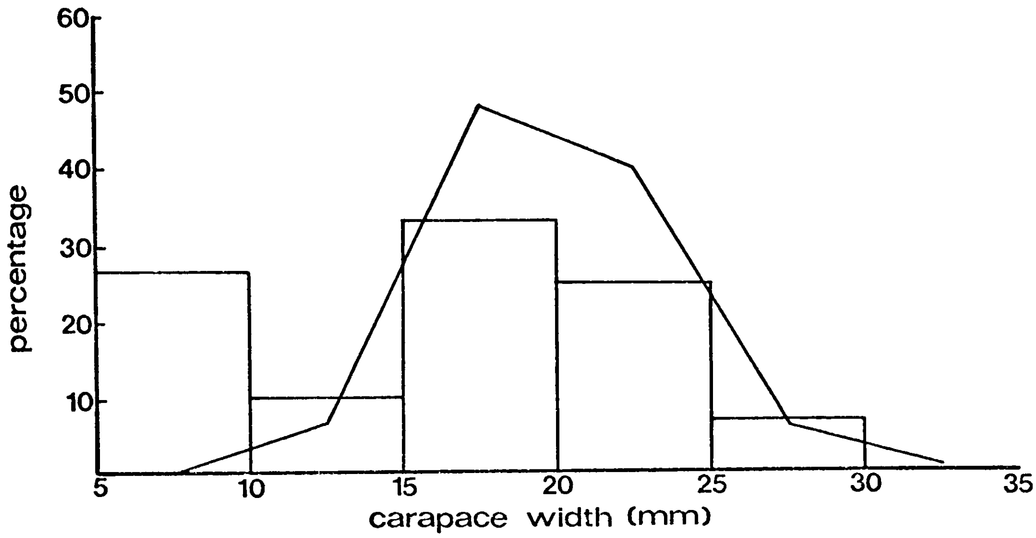



Fig. 19 Frequency distribution of size classes of *Cyclograpsus punctatus* collected with rotenone (histogram) and estimated from chelae in spraints.

did not differ significantly from this ($p < 0,005$)). If for example 100 chelae had been measured and 10 of these were too large to belong to females, 40 of the remaining 90 measurements would be selected randomly and male equations applied to these. The female equations would be used for the other 50.

Estimates of frequency of size classes taken, based on the above procedure, correlate very well with the frequency distribution of size classed collected with rotenone (Figure 19). Crabs of 15 to 20 mm were most abundant in the high tide pool as well as in the diet of otters, followed by crabs of 20 to 25 mm. For reasons unknown, crabs of 10 to 15 mm were rare in the pool, and they also appear to be unimportant in the diet. Once again, although crabs of 5 to 10 mm were abundant in the pool, they were apparently not eaten by otters. The one estimate above 30 mm (33 mm) may have been the result of a wrong measurement, although such a size would probably not be impossible.

Average size taken was estimated to be about 20 mm, or 3,4 g (Figure 20). About 26% of all organisms eaten were estimated to be brown rock crabs, but due to the low average weight, they make up only about 6% of the biomass (Table 16). Turnbull-Kemp (1960) estimated that the soft parts of fresh-water crabs make up about 34% of the total wet weight. If it is assumed that the ratio is more or less the same in *Cyclograpsus*, it becomes apparent that these crabs are relatively unimportant in satisfying the nutritional needs (including energy) of otters.

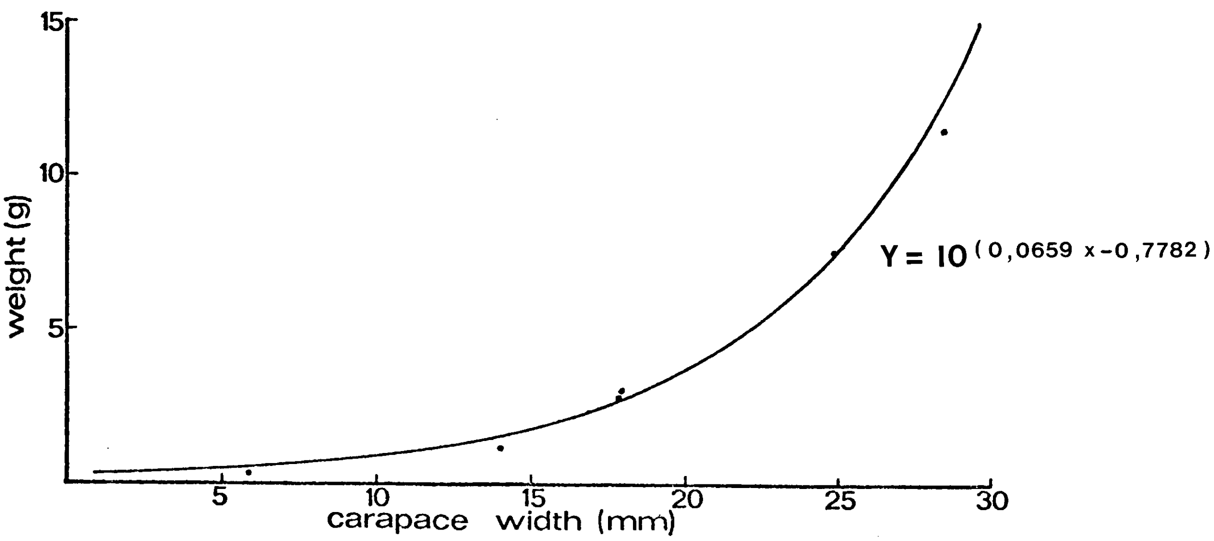



Fig. 20 Carapace width as estimator of weight of *Cyclograpsus*.

It is suggested that there may be two main reasons why Cyclograpsus is caught in relatively large numbers. The first is that it is probably very easy to catch without a large expenditure of energy. The second is that these crabs are ideal prey for juvenile otters to practise their hunting technique on before they are able to negotiate deeper and rougher water.

Family Potamonidae

Potamon perlatus (Milne-Edwards)

The unimportance of fresh water crabs in the diet (0,3%) appears to be a clear indication that Aonyx very seldom hunts in fresh water in the Tsitsikama National Park. The crabs that are eaten are most probably caught while the otters move from their lair towards the sea. One instance was actually observed where an otter caught a crab which it happened to pass while playing around in a fresh water pool before entering the sea.

No estimates of sizes taken were attempted.

No quantitative sampling was done in fresh water, but crabs were regularly seen and definitely not scarce.

Section Macrura
Superfamily Nephropsidea
Family Palinuridae

Jasus lalandii (Milne-Edwards)

Although crayfish are often important in the diet of otters (Sheldon and Toll 1964, Erlinge 1967, Knudsen and Hale 1968, Toweill 1974), the Cape rock lobster is seldom eaten by otters along the Tsitsikama coast. Along the Shetland coast, lobsters also appear to be of minor importance in the diet of Lutra lutra (Watson 1978).

The lack of lobsters in the diet of otters is most probably related to their scarcity in the Park. Jasus usually appears to be associated with kelp beds (Ecklonia spp.), and these too, are very rare in the park (Robinson, *pers. comm.*).

Remains of *Jasus* were only found in spraints of five different holts on both sides of the Storms River Mouth (Table 11). Most remains were found at Mosterd se krans, about 1 km east of Storms River Mouth, with progressively less east and west of this holt. It would appear that there is a local population of *Jasus* in the vicinity of Mosterd se krans. Large pieces of *Ecklonia* were twice seen floating near the Storms River Mouth, which may have indicated that the population of *Jasus* was in fact associated with a local population of *Ecklonia*.

TABLE 11

Importance of remains of *Jasus lalandii* in spraints of five different holts.

| Position of holt in relation to Storms River Mouth: Appr. Distance (km) | Direction | Total weight of remains (g) January 1977 to March 1978 |
|---|---|---|
| 2 | E | 25,8 |
| 1 | E | 75,5 |
| 0,5 | W | 27,7 |
| 0,7 | W | 0,4 |
| 1,5 | W | 2,2 |

Remains of *Jasus* were found during the months of January, February, May, June and August, so that lobsters are probably taken all year round.

Attempts to find lobsters proved unsuccessful.

That lobsters may well be a preferred food if available, was indicated by the high percentage frequency of remains of these in spraints found along the coast of Dwesa National Park in Transkei. The abundance of lobsters in this area was made clear by numerous exoskeletons washed out on the beach. According to Tayler (1970), otters along the coast of the Port Elizabeth area "eat mainly the red rock crab and crayfish".

Other Crustacea

Various small Crustacea were occasionally found in spraints. These included Palaemon sp., Ligia natalensis, Isopods and Amphipods.

Palaemon pacificus was very common throughout the intertidal area, and many were killed by rotenone. It was not regarded as a prey species however, and therefore not collected. Only four Palaemon were recorded in 1251 spraints, which proves clearly enough that otters are not interested in them. Those that were ingested were probably caught accidentally (while trying to catch something else), or they may have been eaten by fish caught by the otters. This was most probably the origin of the other, smaller Crustaceans, as Clinids, for example, are known to prey on small Crustaceans (Penrith 1965, Christensen 1978 a,b). Diplodus sargus is known to eat Palaemon pacificus specifically, as well as various other crustaceans (Christensen 1978 c).

Phylum Mollusca

Class Cephalopoda
Order Octopoda
Family Octopodidae

Octopus granulatus Lamberts

Crabs and fish are found in both fresh water and the sea. When the first otters therefore adopted a marine existence, they could retain their fresh water feeding habits. At least along the Southern Cape coast, however, an additional potential prey animal, the octopus, was now available for exploitation.

The availability of octopuses was definitely exploited. Ivlev's electivity index, using the results of faecal analysis, and sampling in Areas 1 and 2 combined, was calculated at +0,1. For this purpose, Cyclograpsus was not taken into account, because it was not collected in Areas 1 or 2. Octopuses therefore appear to be positively selected, albeit not very strongly. It is important to note, that whereas about 60%

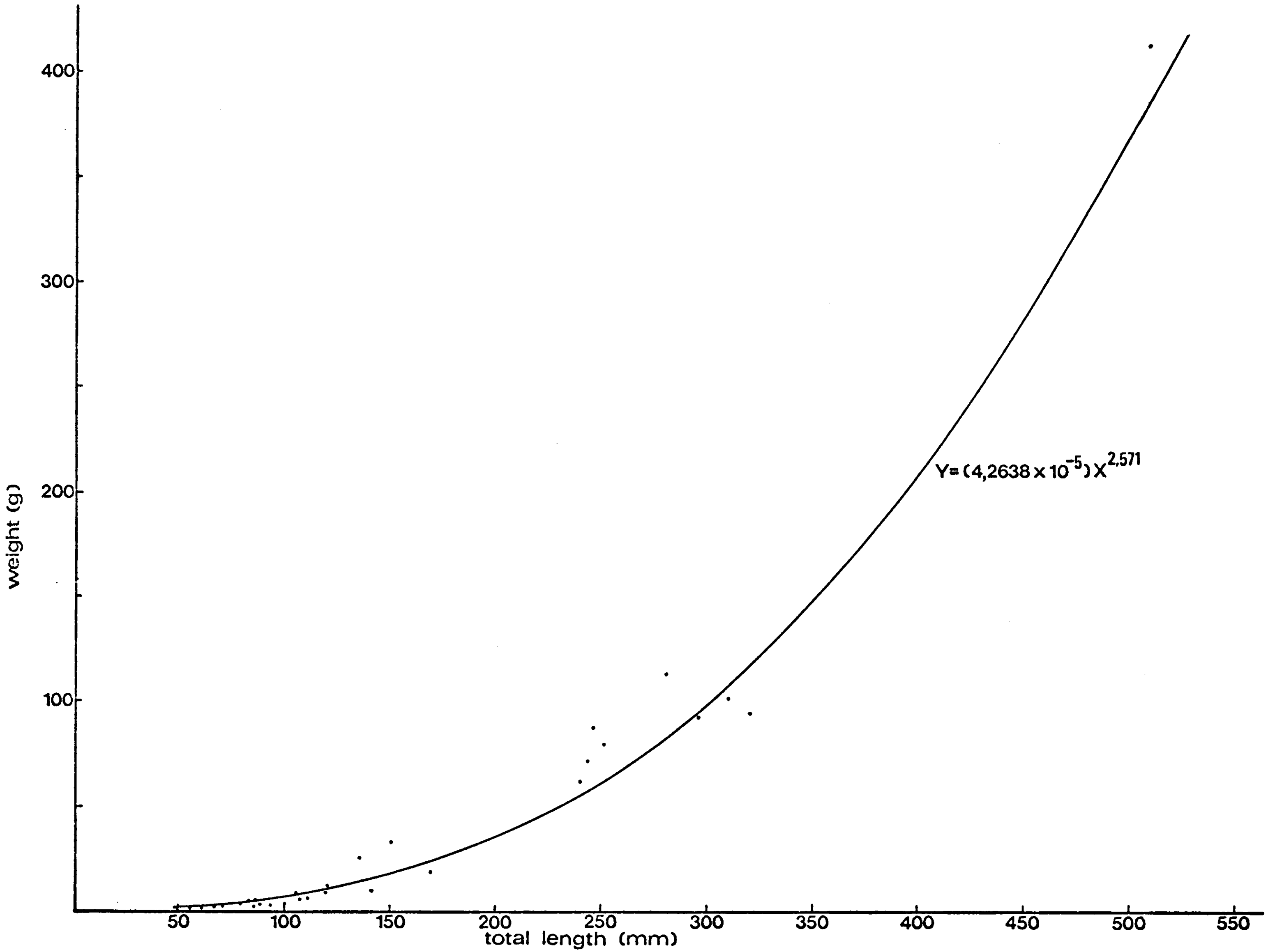



Fig. 21    Total length as estimator of weight of <u>Octopus granulatus</u>.

of octopuses collected with rotenone were smaller than 100 mm (head and tentacles), apparently no octopuses of this size class were taken by otters (Figure 25). This could well explain the slight positive selection. If only size classes taken by otters were to be taken into account, the electivity index would change to +0,5.

*Octopus* was estimated to contribute about 3,7% of the total number of prey organisms of *Aonyx* (Table 16). Because of the relatively high average weight taken, however, (about 138,2 g; Weight = 0,6646 $\text{Length}^{2,679}$ (Figure 21)), contribution to biomass consumed was estimated at 34%. This is nearly the same as the 36,1% estimated for *Plagusia*. This illustrates the importance of taking average size of prey captured into account when considering the importance of a prey item in the diet of an animal.

*Octopus* beaks were too small and light to make any significant contribution to the weight of spraints, and were therefore not included in bulk-weight analysis.

A peak of predation on this species in August and September, was indicated by percentage frequency as well as relative percentage frequency (Figure 22). Figures for summer in 1977 as well as 1978 were much lower.

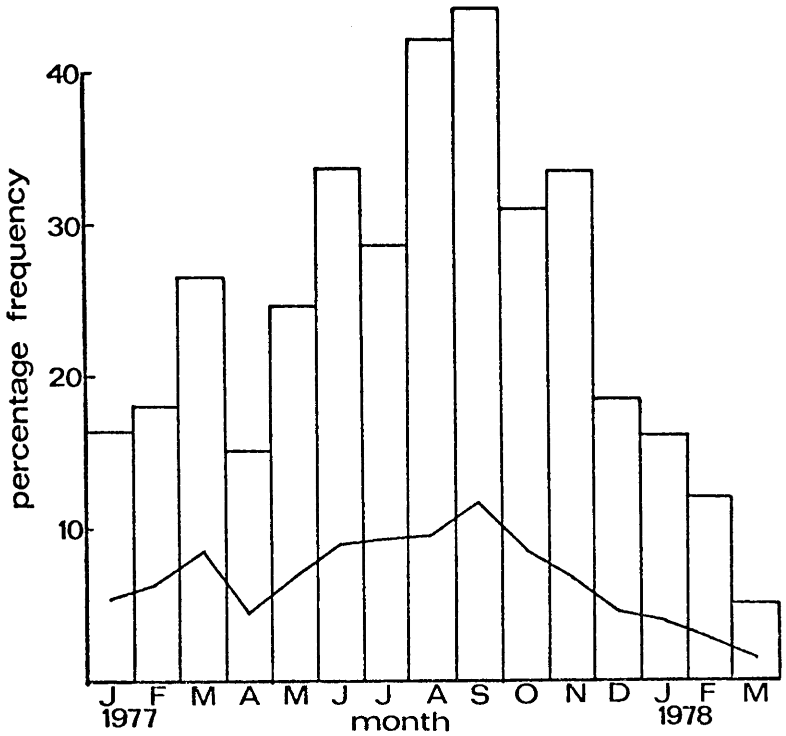



Fig. 22 Percentage frequency (histogram) and relative percentage frequency of *Octopus* beaks in spraints.

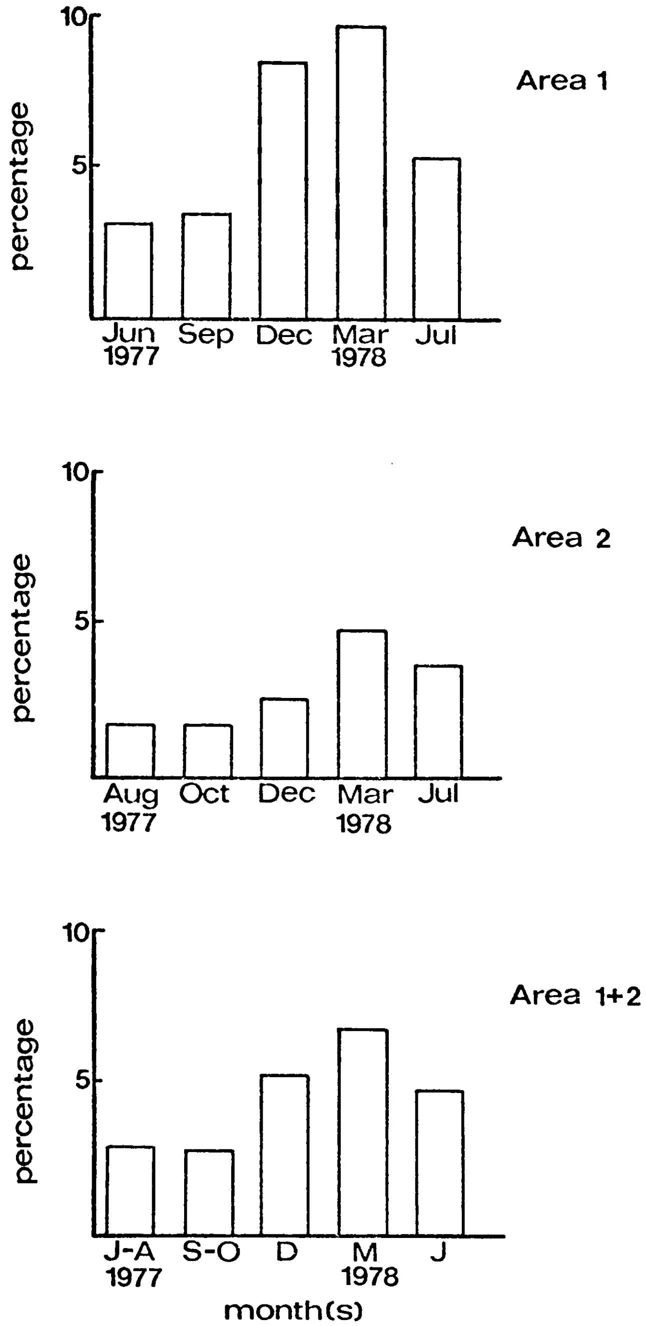



Fig. 23 Frequency distribution of <u>Octopus granulatus</u> from samplings with rotenone in two different areas June 1977 to July 1978.

Data from sampling with rotenone do not explain the seasonal variation (Figure 23). A possible explanation may be that otters prefer to hunt Octopus when the sea is rough, or that octopuses are more available in rough sea. The apparent peak of predation on Octopus coincides roughly with the period when most storms occur in Tsitsikama. During a heavy storm in May, when a female with her cubs was apparently forced by hunger to enter the sea, a large amount of Octopus suckers was found in their spraints the following day.

The beaks of Octopus were used as an index of total length (head and longest tentacle). Two equations were determined, one for the length of the outer beak, and one for the inner beak (Figure 24).

Most octopuses eaten by otters were estimated at about 200 to 300 mm in total length, with an average length of about 234 mm (Figure 25). Except for the size class 0 to 100 mm (actually 20 to 100 mm), this size class, together with the class 100 to 200 mm, appeared to be most abundant in the sea too. From this class onwards frequency distribution of octopuses eaten appears to follow more or less the same pattern of decline as those present in the sea (Figure 25). No octopuses of more than 600 mm were actually collected, but at least three very large ones were seen in or around the infratidal sampling area. These octopuses were not unduly affected by the rotenone and managed to escape without being caught. The estimates of octopuses over 600 mm (maximum length 637 mm) could therefore well be accurate. Once again it appears as if very small octopuses are not worth catching, while from a size easy to catch onwards, selection is related more or less directly to availability.

As in the case of Plagusia, smaller octopuses apparently concentrate in the intertidal area, whereas the larger ones tend to concentrate towards the infratidal area (Figure 25). From this it would appear then that most of the hunting effort towards octopuses is in the infratidal area. In the case of Plagusia, hunting effort appeared to be concentrated in the intertidal area. These two contrasting conclusions may be

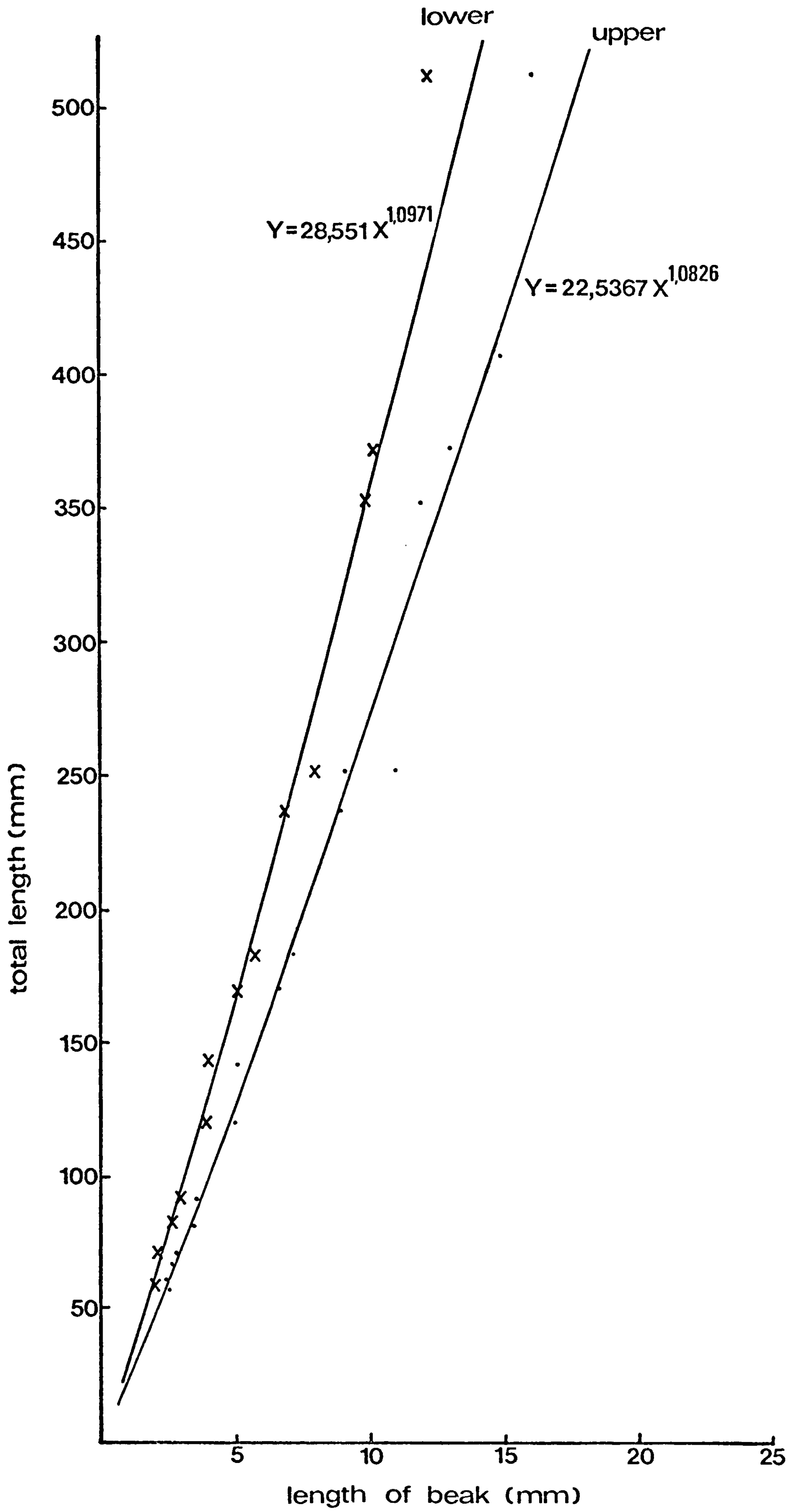
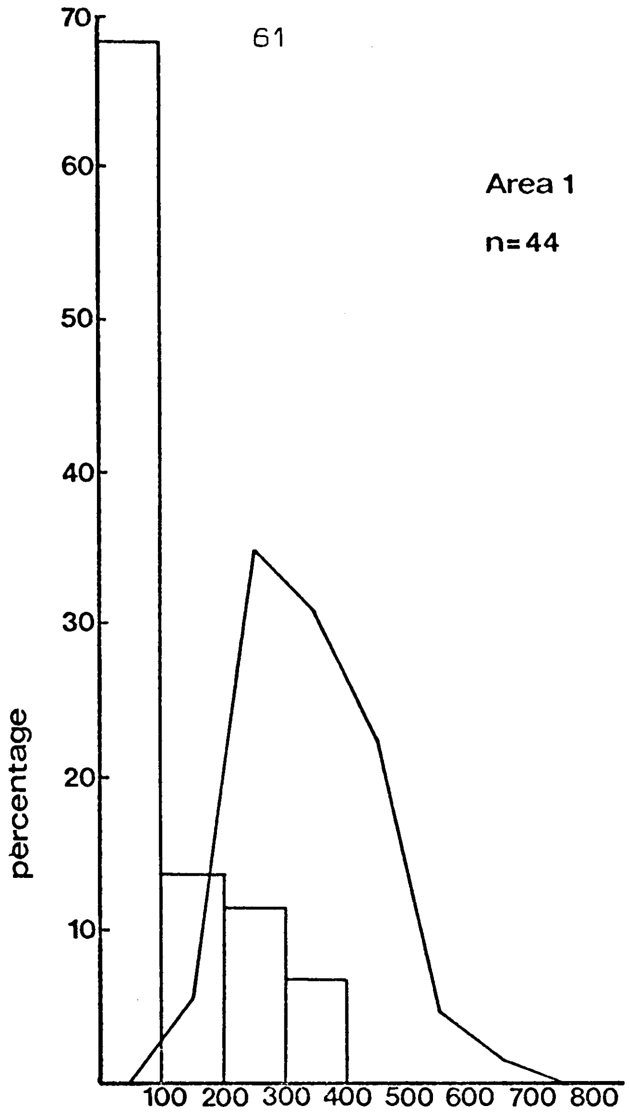



Fig. 24 Length of beaks as estimator of total length of *Octopus granulatus*.



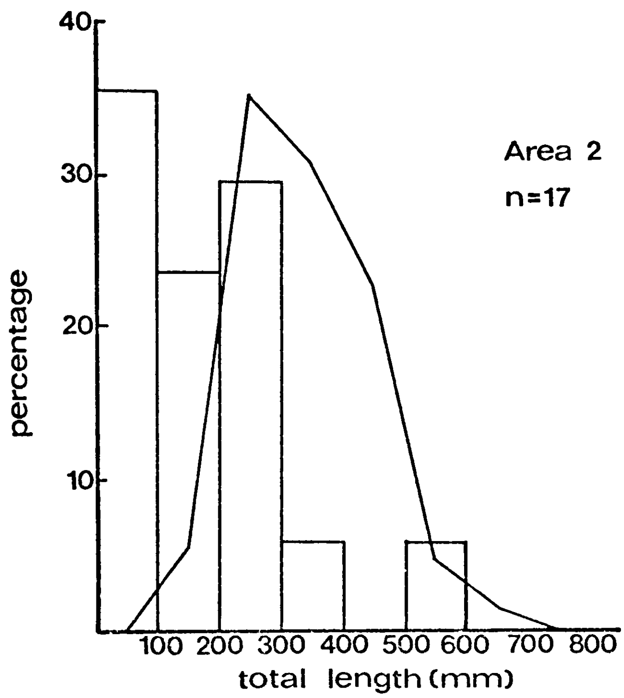




Fig. 25 Frequency distribution of size classes of *Octopus granulatus* collected with rotenone (histogram) and estimated from beaks in spraints.

explained by the hypothesis that relatively more octopuses are caught when hunting in the infratidal area, whereas when hunting in the intertidal area, otters probably catch relatively more Plagusia.

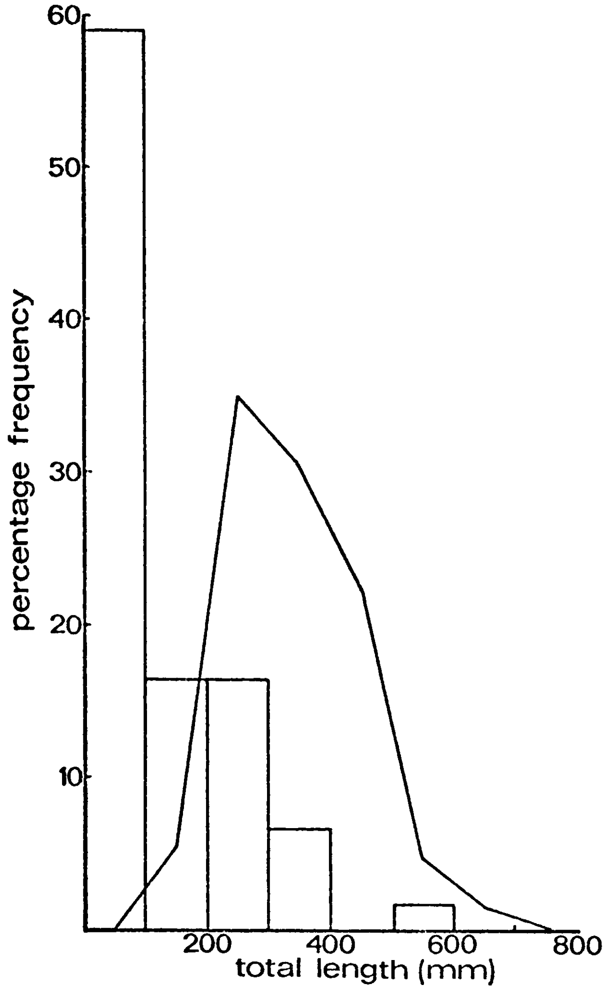



Fig. 26 Size-frequency diagram for Octopus granulatus collected with rotenone (Areas 1 and 2 combined) (histogram) and estimated from beaks in spraints.

Order Decapoda
Family Sepiidae
Sepia tuberculata Lamberts

Five individuals of this species were collected with rotenone, while the remains of four individuals were identified in all spraints analysed. This species is therefore of no importance in the diet of otters.

Shelled Mollusca and Echinodermata

The shells of various Gastropods, Pelecypods and Echinoderms were frequently found in spraints. Most of these, however, were very small, ranging from about 3 mm to 20 mm. Furthermore the presence of these shells nearly always coincided with the presence of remains of *Chorisochismus dentex*. This fish was known to prey on these organisms. It was therefore assumed that all these shells originated from the stomachs of *Chorisochismus* and perhaps other fish. They were not taken into account for the calculation of relative percentage frequency of occurrence.

Phylum Chordata
Class Osteichthyes

| | |
|---|---|
| Subclass | Neopterygii |
| Order | Percomorphi |
| Family | Gobiesocidae |

*Chorisochismus dentex* (Bloch)

An estimated 9,2% of the diet of otters consisted of rocksuckers (Table 16). This estimate was based on numbers taken, but the estimate of percentage contribution to weight taken (10,7%) was not much different. *Chorisochismus* therefore appears to be the third most important prey item in the diet. It is by far the most important fish taken.

Of all prey animals taken by rotenone, 9,1% were *Chorisochismus*. This does not differ much from the estimated 10,4% in the diet of otters. When *Cyclograpsus* is not taken into account, Ivlev's electivity index works out to +0,2, indicating some positive selection. This would be expected from the foraging behaviour of *Aonyx*. An important mode of foraging is to feel in between and underneath rocks with the forefeet (Rowe-Rowe 1977 b, personal observation). As rocksuckers cling to rocks by means of their suckers (modified pelvic fins) most of the time, they should be relatively easy to catch. It is surprising that Tayler (1970) does not mention this fish, as even on the Transkei coast remains of rocksuckers were common in spraints.

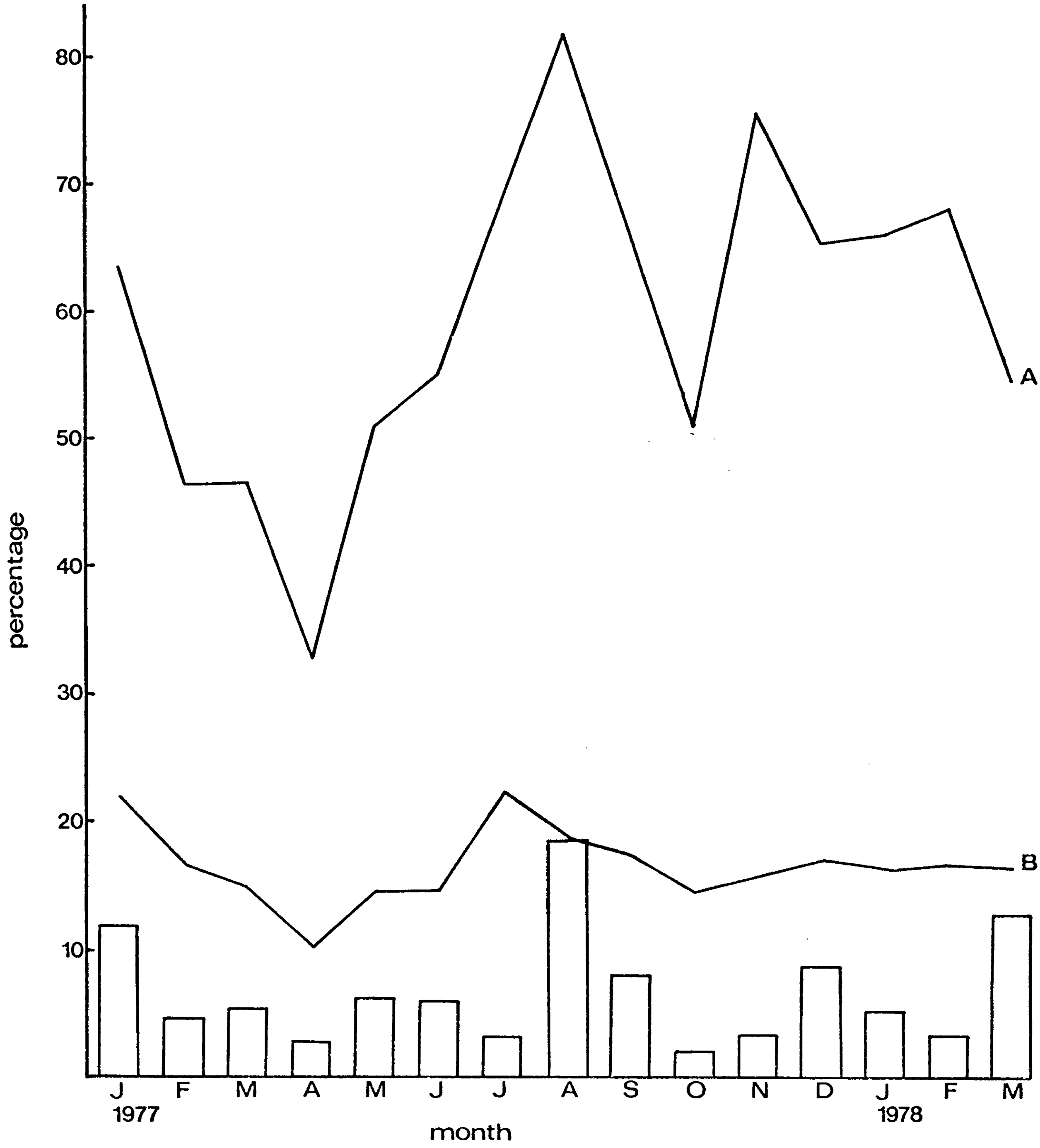



Fig. 27 Chorisochismus dentex : Monthly variation in % weight (histogram), % frequency (A) and relative % frequency (B) of remains in spraints

Some monthly variation in the importance of rocksucker remains in spraints was present (Figure 27). Peaks of importance in January and August 1977 show in percentage frequency as well as percentage weight, while these two methods also show low importance values in April and October. Spraints of four different holts were analysed separately (Figure 28). The peaks in January, August, and December and possibly March, and the low values of April and October appear to be fairly general, but again, as in the case of Plagusia, there was considerable variation.

An explanation for these variations is very difficult to find. Sea temperature or season offers no explanation, as the peaks occur in the months with the warmest as well as coldest sea temperatures. Nor do data from the rotenone programme offer any explanation. Chorisochismus is apparently no great colonizer, as the large number (39) collected in Area 1 in June 1977 was not repeated during the next sampling. Only 16 were collected in September and 7 in December. In Area 2 only one rocksucker was collected in August 1977, while following samplings yielded 19, 25, 9 and 1 respectively. Obviously there is no correlation with the importance in the diet of otters. In the diet the highest percentage weight of spraints was in August and the lowest in October, while in the collections with rotenone it was almost the other way round.

Seasonal differences in behaviour and/or reproduction of rocksuckers may perhaps be responsible for changes in predation rate, but apparently no results are available on these aspects of Chorisochismus. The last alternative may simply be sampling error due to the heterogeneity of the inter- and infratidal zones, even though some of the monthly differences are highly significant ($p < 0{,}005$).

Sizes of rocksuckers eaten by otters were estimated from the length of premaxillas in spraints (Figure 29). When including the teeth in the measurement, the equation used was $Y = 10{,}3438\ X^{0{,}8299}$, with a standard error of 0,013. This was slightly more reliable than the equation used for measurements without the teeth, $Y = 10{,}0914\ X^{0{,}8945}$, in which case the standard error was 0,021. Many of the premaxillas found in spraints, however, were without teeth.

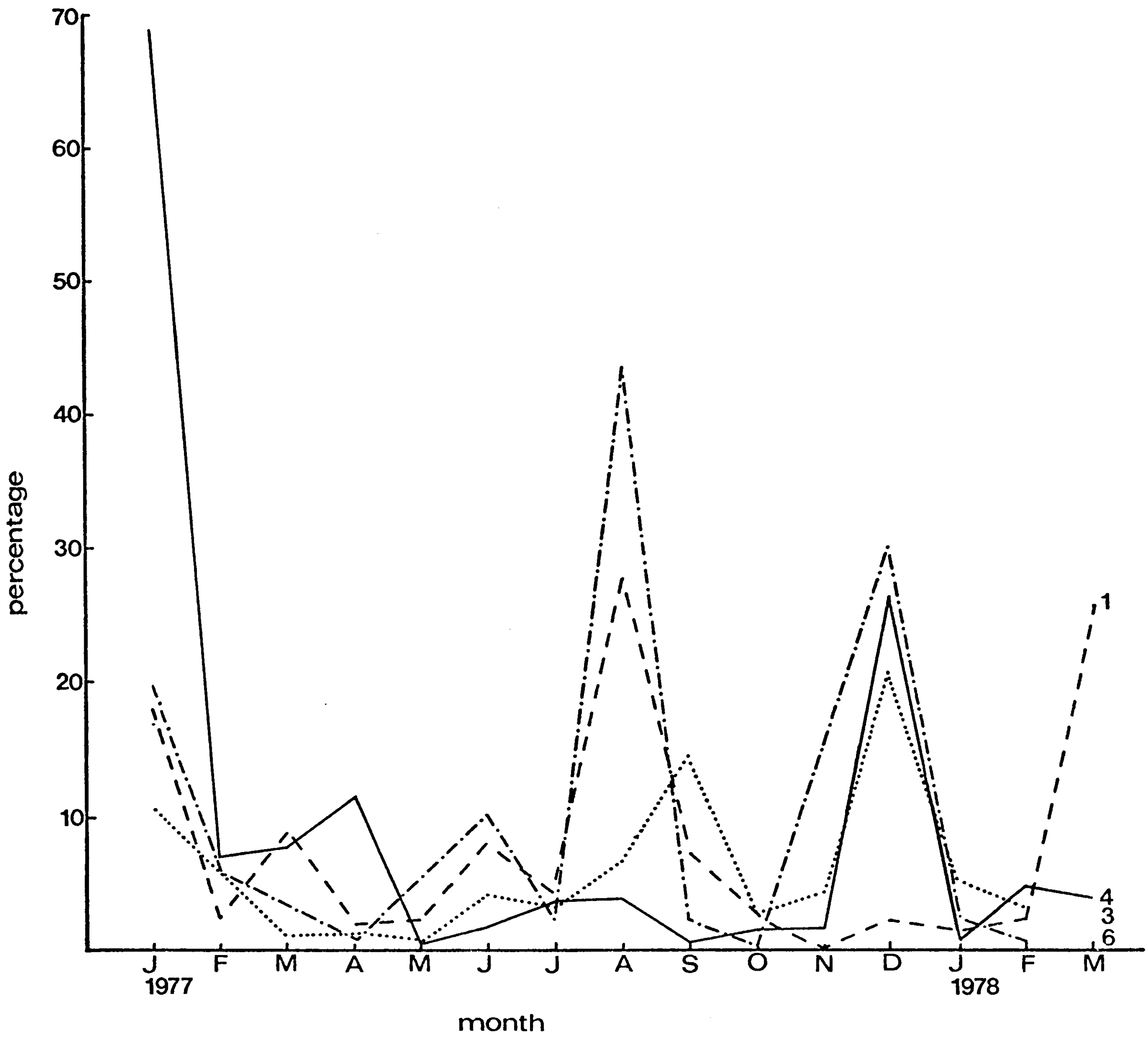



Fig. 28 Percentage weight of remains of Chorisochismus dentex in spraints of 4 different holts. Holt numbers refer to Fig. 41.

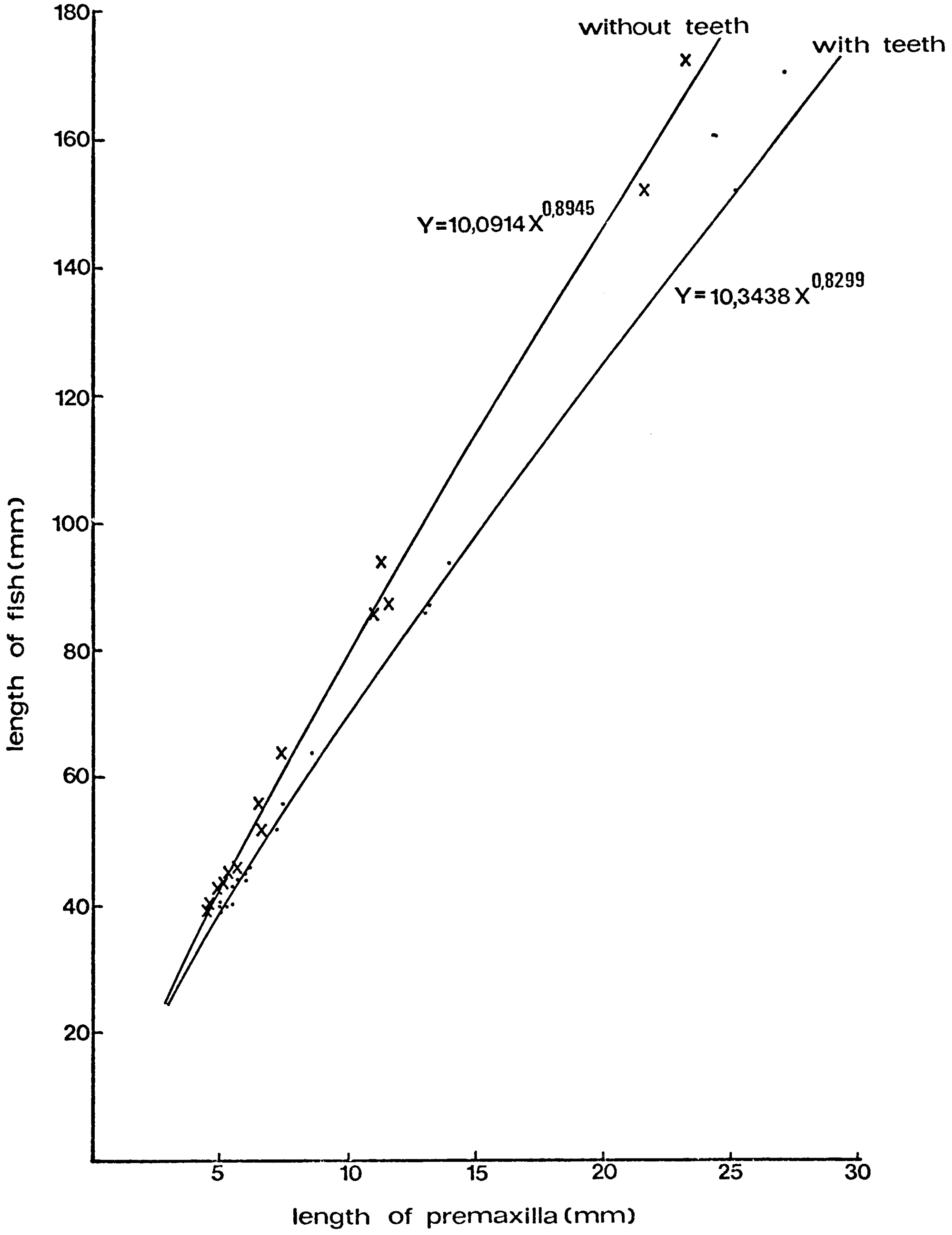



Fig. 29 Length of premaxilla as an estimator of length of <u>Chorisochismus dentex</u>.

Selection of size classes followed about the same pattern as in the case of Octopus (Figure 30). The youngest class of 10 to 30 mm, although very common (Figure 31), was not preyed on at all. Predation on fish of 30 to 50 mm, apparently the most common size class in the sea, was limited. About 67% of rocksuckers eaten were estimated to be between 50 and 110 mm, whereas about 37% of those collected with rotenone fell within this range.

Differences between monthly estimates of average size taken varied considerably; from 67,8 to 107,2 mm (Figure 32). This was probably due to too small sample sizes, as no clear pattern of a shift in selection could be distinguished (Figure 30). When the results of all 15 months were totalled, a much better distribution than for individual months resulted, with a sample size of 791. The average size of 93,3 mm calculated from this is therefore regarded as fairly reliable. Average weight as estimated from average length, was then 17,3 g (Figure 33).

Although sample sizes of collections in Area 1 as well as Area 2 were rather small, concentration of juveniles in the shallower area was again in evidence (Figure 31). Predation centred in the medium size classes, with very little predation on the smallest fish, and predation of larger fish being more or less in proportion to their abundance. As no rocksuckers larger than 94 mm were ever found in Area 1, it may be assumed that predation is heaviest in the infratidal zone. In Area 3, the tidal gully, large Chorisochismus were also found, but only two of them, so that this is probably not an important habitat for them. No rocksuckers were ever found in deep, protected pools.

Apletodon knysnaensis

Remains of only one of this small species of suckerfish were found in all spraints analysed. A total of 11 Apletodon were collected out of 975 fish collected with rotenone. Ten of these were 38 mm or less, in accordance with Smith and Smith (1966), but the other one had a length of 54 mm. Beside the fact therefore, that these fish were rare, most of them are too small to be caught by otters.

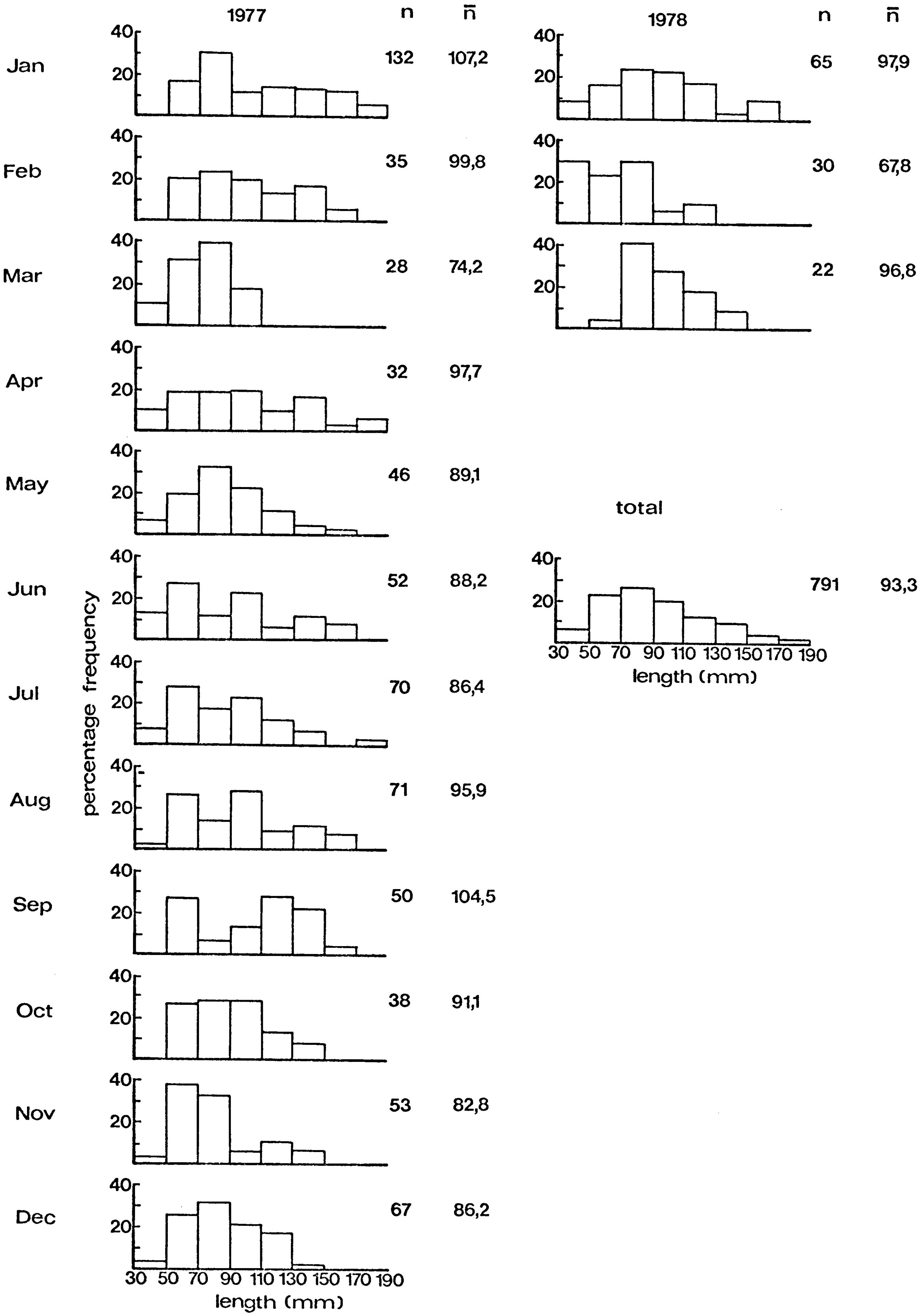



Fig. 30 Length-frequency diagrams of Chorisochismus dentex taken by otters January 1977 to March 1978. Estimated from premaxillas in spraints.

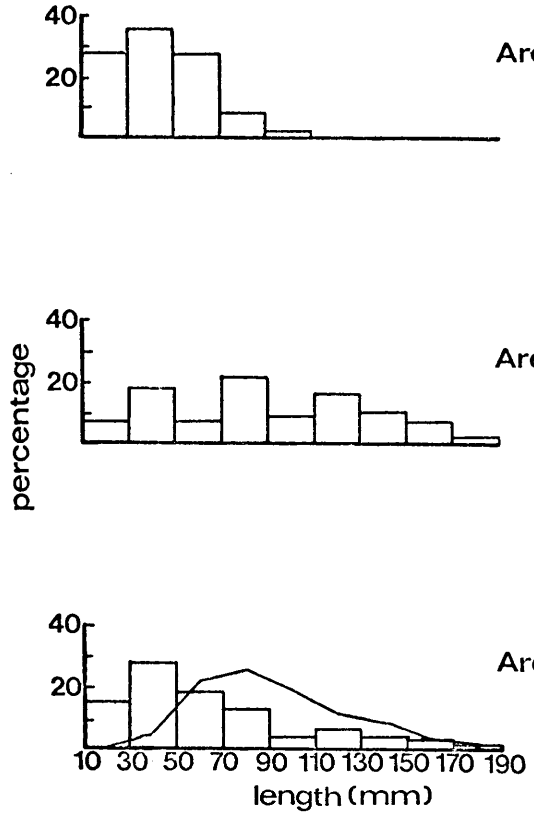



Fig. 31 Frequency distribution of size classes of Chorisochismus dentex collected with rotenone (histogram), and taken by otters, as estimated from premaxillas in spraints.

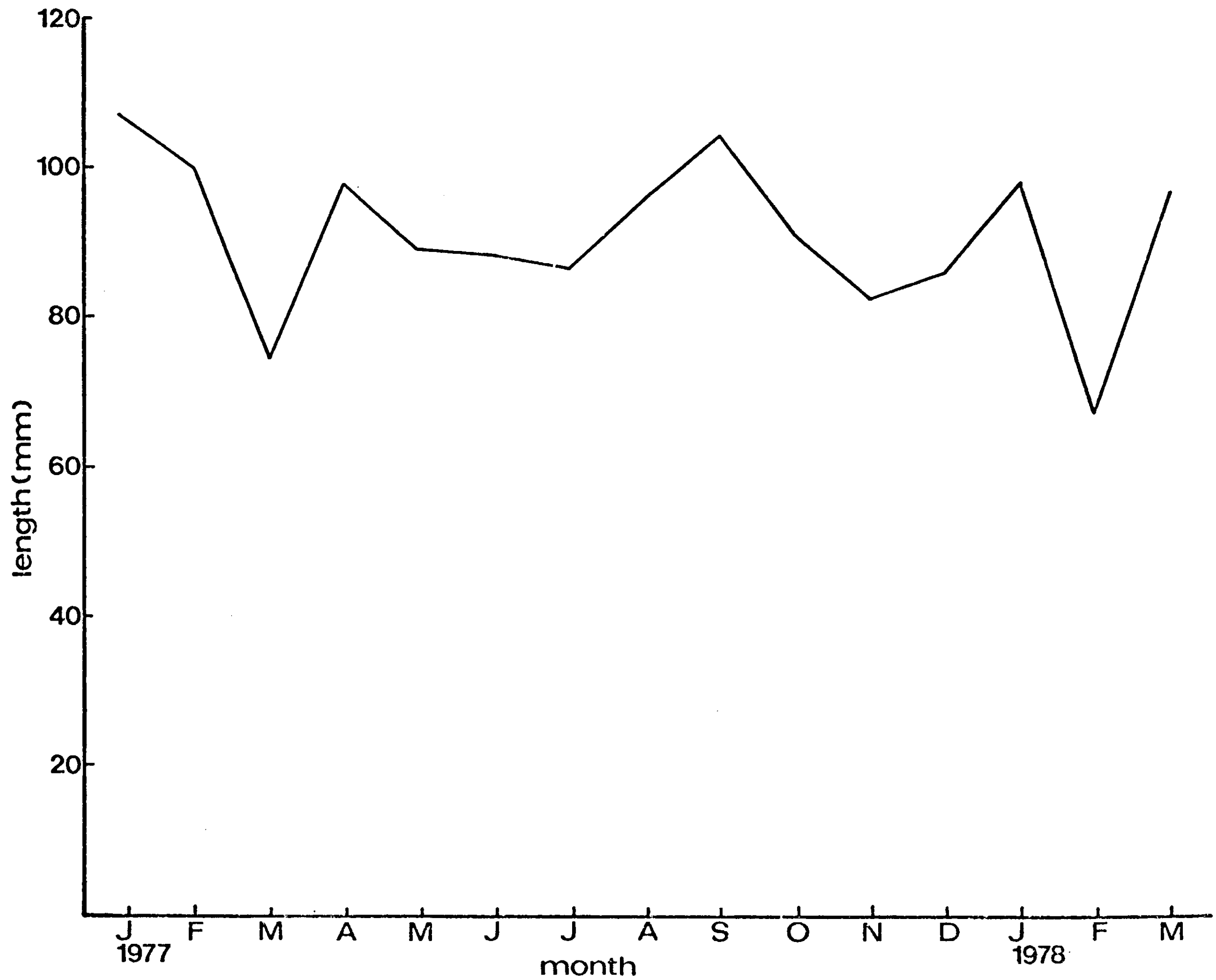



Fig. 32 Average monthly length of Chorisochismus dentex taken by otters,

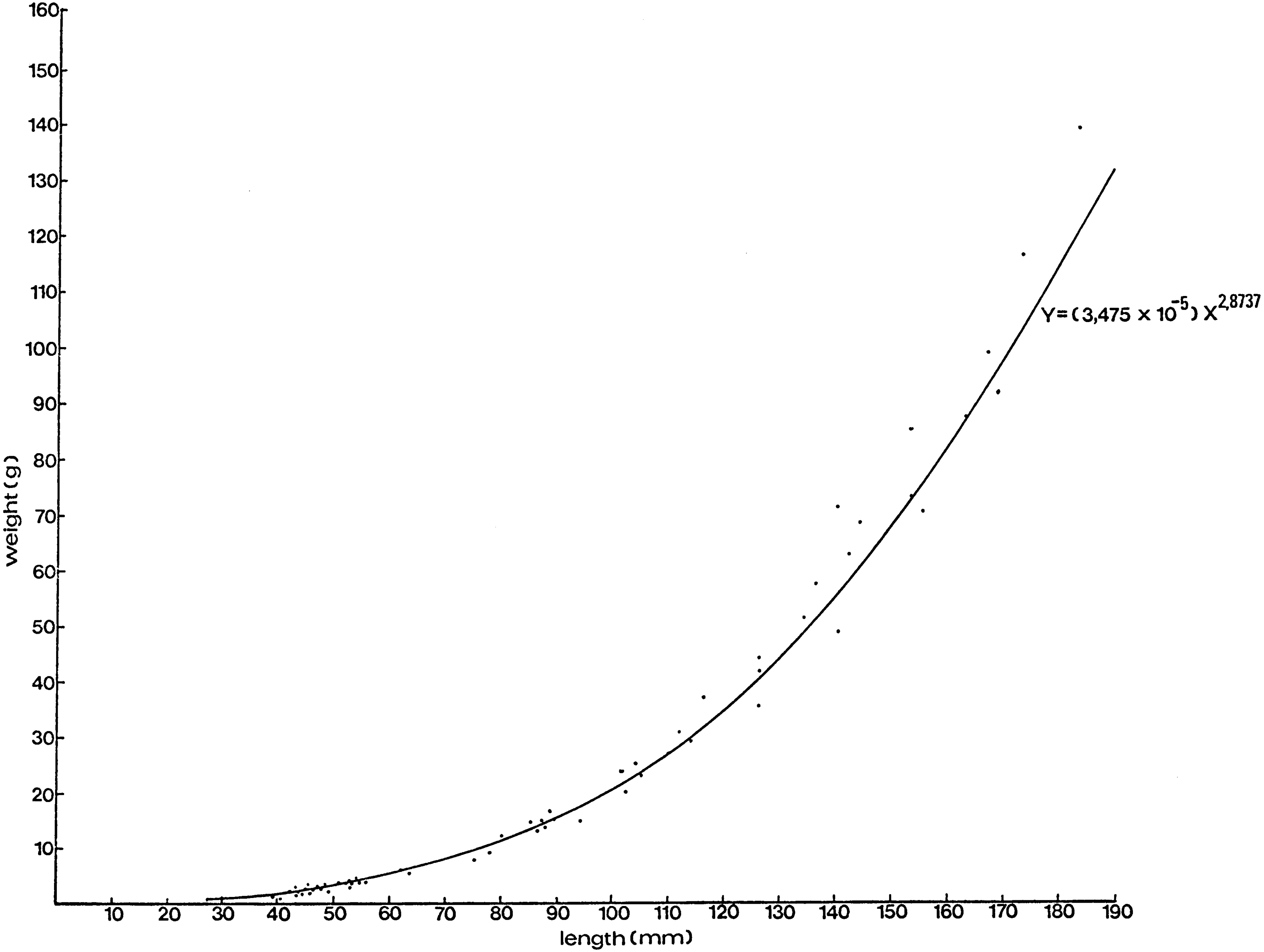



Fig. 33 Length of Chorisochismus dentex as estimator of weight.

Family Clinidae

Clinus cottoides Cuvier
Clinus superciliosus (Linnaeus)
Clinus capensis (Cuvier)
Clinus anguillaris C & V
Clinus taurus Gilchrist & Thompson
Pavoclinus graminis Gilchrist & Thompson
Pavoclinus pavo (Gilchrist & Thompson)

Fishes belonging to this family, the well-known klipfishes, could probably be regarded as the most typical fish of the rocky intertidal area of the Southern Cape coast. They certainly are the most abundant (Day, 1974). In Areas 1 and 2 they made up 73% and 64% of all fish collected respectively, giving an average of 70% for the two areas combined. It would seem surprising then that only a relatively small portion of the diet of otters consisted of clinids.

For the purpose of this discussion all clinids are treated together. Until May 1977 the only clinid that could be distinguished from the rest in spraints was Clinus capensis, not a very important species. In January 1977 a collection of fish was made in a very quiet pool by means of bait and a net, and all clinids collected this way were Clinus superciliosus (also the most important clinid in Area 3, the tidal gully (Table 7)). All remains of Clinidae in spraints were therefore identified as Clinus superciliosus. Only after the first samplings with rotenone in June 1977, was the variety of clinids present discovered, and the fact that Clinus cottoides was by far the most important clinid present. By this time all spraints had been analysed, and to re-analyse them would not have been worthwhile. Even after this, distinguishing between remains of different species sometimes proved difficult. Pavoclinus graminis, Pavoclinus pavo and Clinus capensis had very characteristic premaxillas and other bones, while those of Clinus cottoides and Clinus superciliosus had only slightly different proportions. Species which were likely to have been confused at times, were Clinus cottoides, Clinus superciliosus, Clinus anguillaris, and possibly Clinus striatus, Clinus robustus, Clinus acuminatus, Pavoclinus mus, Blennioclinus brachycephalus and Blennioclinus stella. From the collections with rotenone however, it was obvious that of all these only Clinus cottoides and Clinus superciliosus could have been of any importance (Table 6) and confusion between these two was limited.

The high proportion of unidentified Clinidae, is mainly the result of the abovementioned errors, as all Clinidae up to May 1977, except Clinus capensis, were simply classified as unidentified Clinidae.

Remains of clinids were typically abundant in spraints as indicated by percentage frequency, but contribution to weight was very low (Figure 34). From January to December 1977 the remains made up only an estimated 1,14% of the total weight of all spraints. After application of corrective factors, this was estimated to represent about 633 clinids, not significantly different from the final estimate of 694 clinids taken during 1977. The low contribution of remains to volume/weight can be attributed to the high ratio of live weight : weight of hard parts (± 21 : 1) (Table 13) and the small average size taken (estimated at 3,2 g).

Seasonal variation appears to be of very little importance (Figure 34). Correlation between percentage weight and relative percentage frequency is not good. In this case, relative percentage frequency is perhaps more reliable, as the estimation of the volume of remains occuring in small quantities is much more difficult and inaccurate than of those occurring in large quantities.

For the purpose of comparison throughout the study period, no distinction was made between species, but when all species are scored separately, percentage frequency as well as all relative percentages are obviously higher (Figure 34). Fortunately, analysis by weight is not affected by this.

Fluctuations in numbers collected with rotenone were also limited, save for a few explainable exceptions (Tables 4, 5 and 6). In Area 1 clinids collected in March 1978 made up only 32,5 of the total catch in comparison with the 54,2% of December. During this sampling all Sargassum heterophyllum had died off, and as clinids are very dependent on cover, including seaweeds (Marsh et al. 1978) they had probably moved off to areas with more cover.

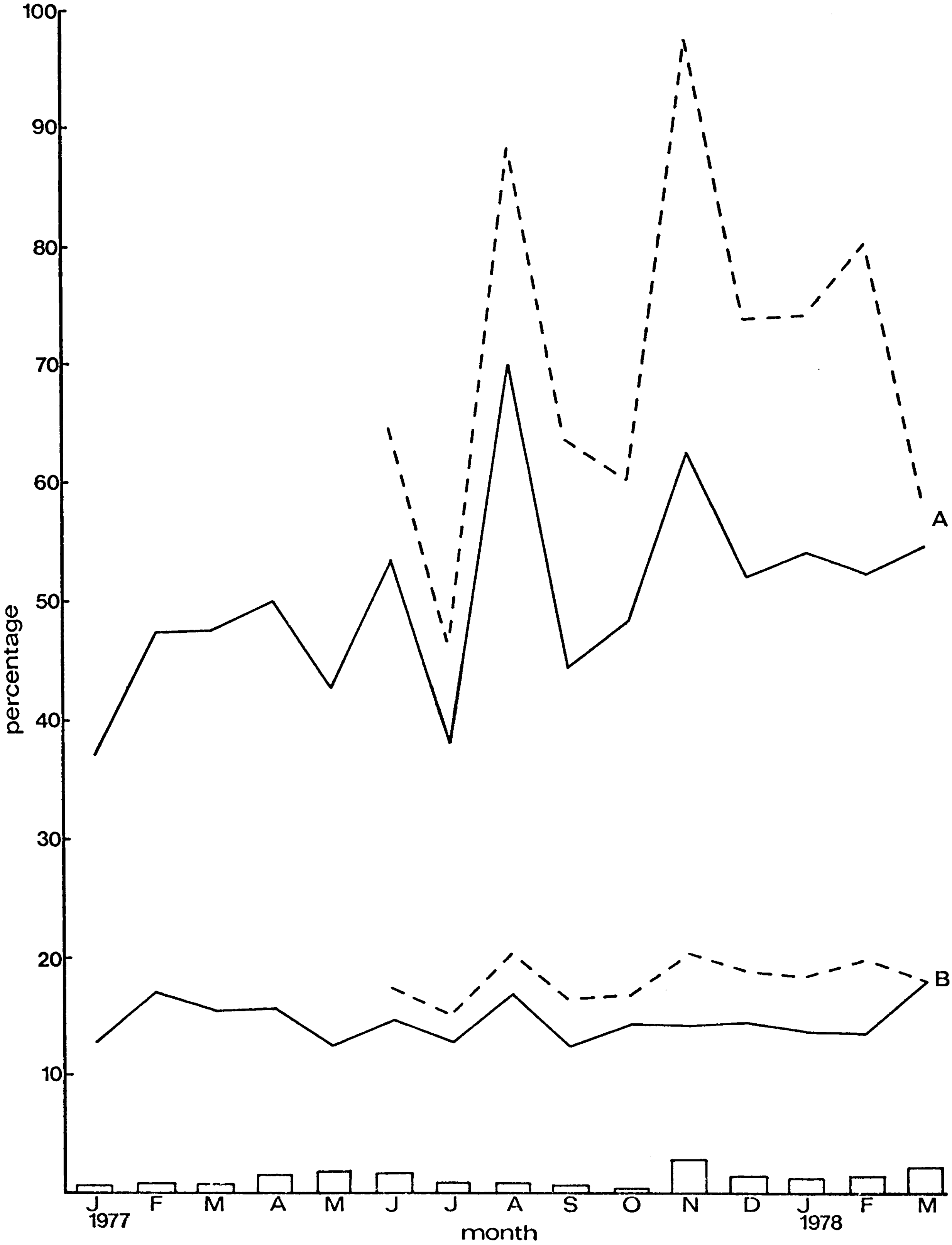



Fig. 34 Monthly variation in % weight (histogram), % frequency (A) and relative % frequency (B) of remains of the Clinidae in spraints during the study period.

———— No distinction between species

- - - - - Distinction between species

In Area 2 the proportion of clinids collected in December was fairly high, but it is noteworthy that this was mainly the result of a sudden large number of Pavoclinus graminis and Pavoclinus pavo collected. The number of Clinus cottoides collected, was actually relatively small. This collection was done under ideal conditions slightly deeper into the sea than other collections. The collection area was probably a slightly different microhabitat with more seaweed, favouring the two Pavoclinus species.

In July 1978 the proportion of clinids collected in Area 2 was exceptionally high (69%) but as explained before, this subsection was very different from the other subsections, causing the results to be rather unreliable.

It was estimated that the Clinidae made up about 8,6% of the number of organisms caught by otters, but contribution to biomass caught, was estimated at only 2,9%. (Table 16). If it is taken into account that 52,8% of all prey organisms collected in Areas 1 and 2 were Clinidae, the avoidance of Clinidae becomes apparent. Ivlev's electivity index in this case (not taking Cyclograpsus into account) was -0,6, indicating very strong negative selection.

When Ivlev's electivity index was calculated for the individual species, taking only the Clinidae into account, it appeared as if all species were not caught in proportion to their abundance (Table 12). Clinus cottoides, making up 60% of all Clinidae collected in Areas 1 and 2, was apparently not specifically selected positively or negatively, while a strong selection of Clinus superciliosus and Clinus capensis appeared to be present. Pavoclinus graminis and Pavoclinus pavo were apparently negatively selected, Pavoclinus pavo far more so than Pavoclinus graminis. The other species were too rare in the sea as well as the diet to use the index on.

TABLE 12

Selection of different species of Clinidae.

| Species | % of all Clinidae eaten | % of all Clinidae in sea* | E |
|---|---|---|---|
| Clinus cottoides | 58,0 | 59,7 | -0,01 |
| Clinus superciliosus | 15,6 | 4,5 | +0,55 |
| Clinus capensis | 15,6 | 4,7 | +0,54 |
| Pavoclinus graminis | 8,9 | 13,5 | -0,2 |
| Pavoclinus pavo | 0,9 | 11,3 | -0,9 |

* Total of Areas 1 and 2 combined.

Clinus cottoides was often seen in cracks and holes in the rocks, but also amongst seaweed. Furthermore they apparently have to come out at high tide to feed on barnacle legs (Penrith 1965, Marsh et al. 1978). They would therefore seem to be fairly accessible to otters. Clinus superciliosus appeared to be more plentiful in quiet pools and gullies and were not nearly as secretive in their habits as other clinids. When diving in the inter- and subtidal zone, the only clinid that was frequently and easily seen, was Clinus superciliosus. This may have been a reason for their selection. Another reason may be their larger size (estimated average length taken 95 mm, in comparison with 71 mm for Clinus cottoides). Clinus capensis was usually found hiding under large rocks, and this species was also much larger than Clinus cottoides (average length taken 122 mm). Pavoclinus graminis and Pavoclinus pavo are two species essentially associated with dense seaweed (Christensen 1978 b), and it is unlikely that otters do a lot of hunting among the seaweeds.

Sizes of clinids eaten were estimated from two measurements of premaxillas, length and width (Figure 35). Selection of size classes followed the same pattern as in previous species again, with complete avoidance of the smallest classes and heavy predation on the larger classes (Figure 36). Differences in size classes collected in Areas 1 and 2 were not very marked this time and the bulk of predation could have been anywhere in the lower intertidal or subtidal zones.

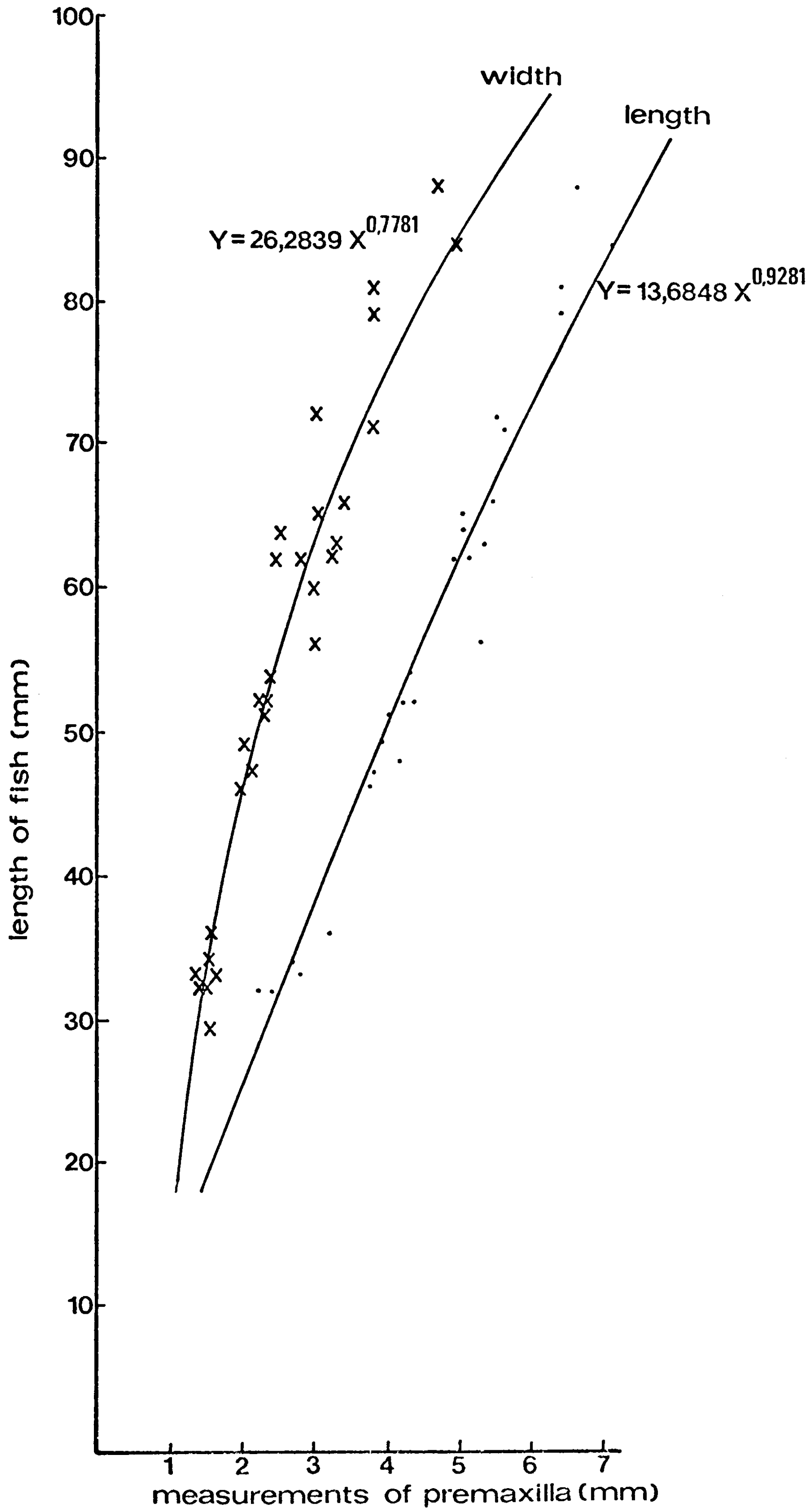



Fig. 35 Measurements of premaxilla as estimators of length of *Clinus cottoides*.

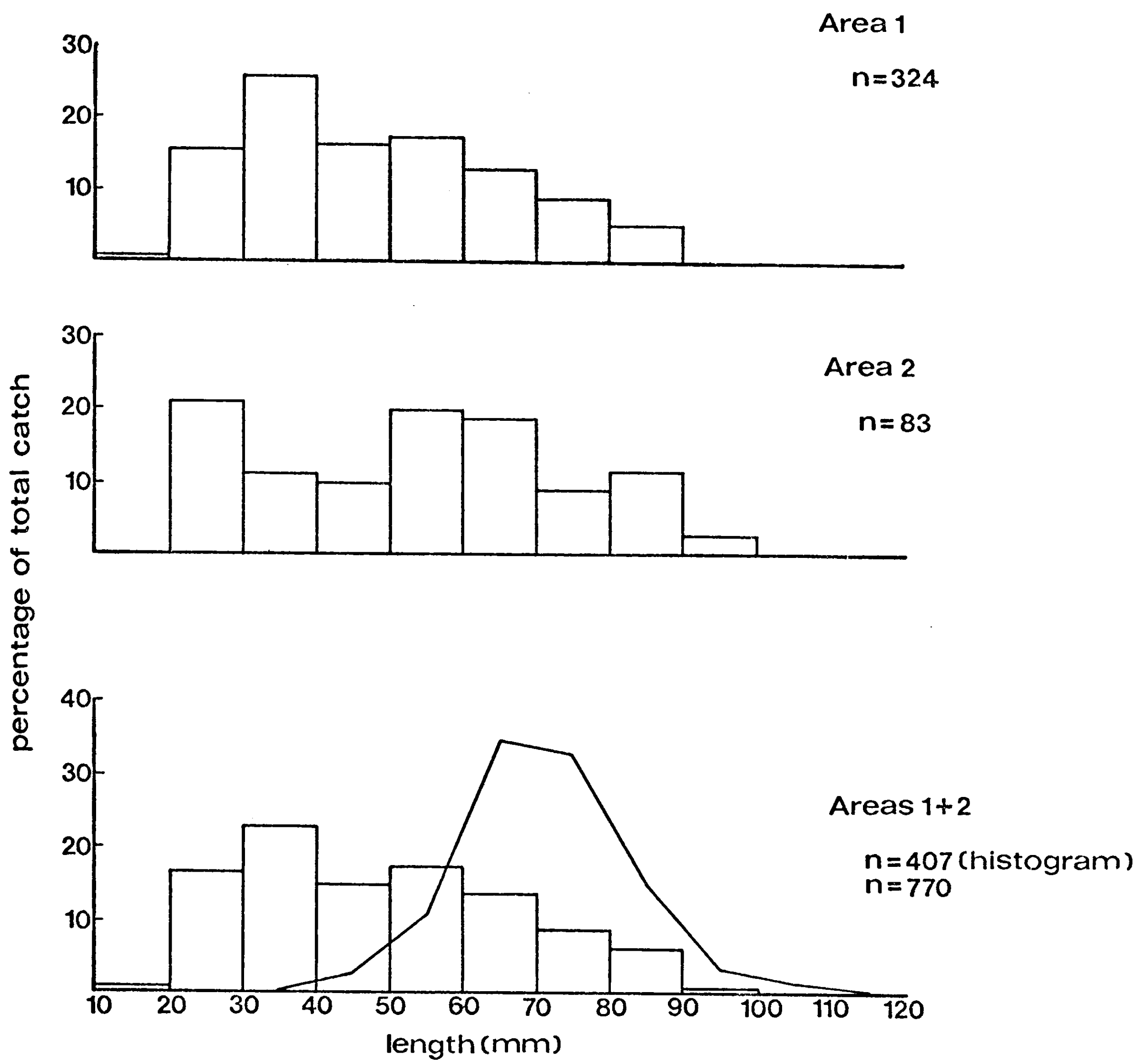



Fig. 36 Frequency distribution of size classes of <u>Clinus cottoides</u> collected with rotenone (histograms) and eaten by otters, as estimated from remains in spraints during the study period.

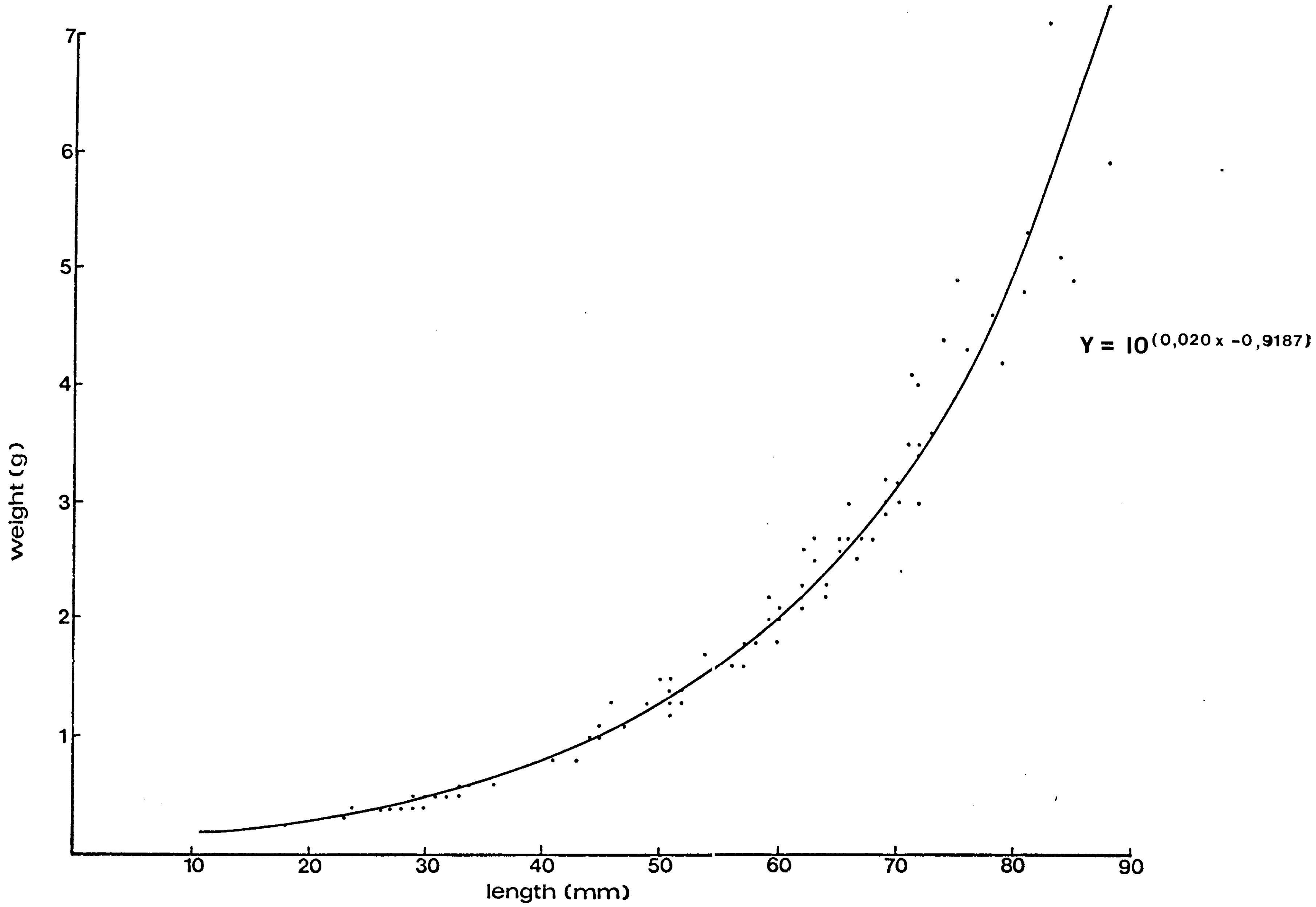



Fig. 37 Length of _Clinus cottoides_ as estimator of weight.

Family Blenniidae

Predation on blennies was very much the same as on clinids. From an otter's point of view there is probably no difference between a blenny and a clinid. Both are rather small, relatively slow moving fish never moving far from their shelters (Marsh et al. 1978).

Two species of blenny were normally present, although a third, very rare species was collected once. Blennius cornutus was most common (7,4% of all fish collected in Areas 1 and 2), while Blennius fascigula was apparently not as common. Only 0,4% of all fish collected in Areas 1 and 2 were this species, but in Area 3 they made up 6,9% of all fish collected. They appear to prefer quiet water, as a few Blennius fascigula were seen in quiet, deep pools too. The third species collected in Area 1 in September 1977 was Chaladoderma capito.

In the diet of otters, Blennius fascigula was of virtually no importance (0,1%). About 3,2% of the prey of otters was estimated to be Blennius cornutus (Table 16). Some error may be present, as distinction between the bones of the two species was sometimes very difficult. As in the case of clinids, percentage contribution of remains to weight (0,4%) (Table 15) was much lower than total relative percentage frequency (6,8%) (Table 14).

Ivlev's index of -0,1 once again indicated negative selection, although where such small numbers are involved, use of this index is probably not warranted.

Family Gobiidae

Gobius nudiceps Cuvier = Coryphopterus caffer

Only one species of goby was very common high up in the intertidal zone. The taxonomy of the species appears somewhat confused, but the two names indicated appear to be the most commonly used ones. Butler (1978) uses the name Caffrogobius caffer.

Sampling of Gobius with rotenone was not done, as their distribution coincides to a large extent with that of Cyclograpsus punctatus. As only about 1% of the diet of otters consisted of this species (Table 16), sampling was not regarded as necessary. The species was very frequently seen however, and was present in large numbers. It would appear therefore that this species was actually avoided to some extent. This may be explained by the hypothesis mentioned before that predation on Cyclograpsus punctatus, in other words in the higher part of the intertidal zone, was limited to a large extent to female otters with their cubs. It was noticed in a tame otter that at a stage when it was already catching Cyclograpsus, it was still very clumsy in catching fish. It may then be that at a stage when juveniles start catching fish, they are large enough to move deeper into the sea, where no gobies occur.

Average size taken (estimated from premaxillas) was about 8,6 g.

Family Serranidae

Acanthistius sebastoides (Castlenau)
Epinephelus guaza (Linnaeus)
Epinephelus andersoni Boulenger

Although the estimated number of serranids caught was only about 20% of the number of blennies caught, contribution to weight was estimated to be about the same (1,8%) (Table 16). This was the result of a much larger average weight taken.

Only 11 serranids were collected with rotenone in all areas. Weight of Acanthistius sebastoides, the most important serranid taken, varied from 10 g to 50 g, while the weight of Epinephelus guaza varied from 135 g to 330 g. Estimated average weight of Acanthistius taken (from premaxillas) was 35 g (n = 15).

Serranids were apparently taken more or less in proportion to their abundance (E = +0,17), which was low, but because they are relatively large, they contributed nearly two percent to the total weight of the prey of otters.

Family Cheilodactylidae

Palunolepis brachydactylus (Cuvier)
Cheilodactylus fasciatus Lacepede

Palunolepis brachydactylus is the well-known butterfish, or steenklipvis, of the Southern Cape coast. It is frequently seen by divers. Only an estimated 1,2% of the diet of otters however, consisted of this fish (Table 16).

Although butterfish become fairly large (spearfishing record 2,9 kg) (Smith and Smith 1966), only juveniles were taken by otters. Average size was estimated from premaxillas (n = 30) at 5,8 g. Large fish may have been taken very occasionally, as a few of the remains of unidentified fish belonged to large fish. These would, however, not be of any importance.

Twenty-one Palunolepis brachydactylus were collected with rotenone in all areas, varying from 2 g to 43 g. Nearly all the very small ones came from Area 3. These Spariform fishes are much more mobile than the other fish discussed so far and were able to move out of the sub-sections of Area 2 before rotenone could have any effect on them. This resulted in only one specimen being collected here. Although fish could not easily move out of the other two areas, the results should still not be regarded as reliable, because of the continual, extensive movement of these Spariform fish. From visual observations it was established that juvenile butterfish were mostly found in intertidal rockpools and small gullies. It would seem likely then that these fish are caught by cornering them in small pools. Something which enhances this hypothesis is the fact that frequently whenever Palunolepis was scored, remains of more than one were present. This was very seldom the case with other organisms of lesser importance, except the Sparidae.

Cheilodactylus fasciatus was much rarer than Palunolepis in the sea as well as in the diet of otters. It was occasionally seen in quiet, deep pools. This species can be regarded as an occasional prey item of no importance to otters.

Family Sparidae

*Diplodus sargus* Linnaeus
*Sparodon durbanensis* (Castlenau)
*Rhabdosargus tricuspidens* Smith
*Lithognathus mormyrus* (Linnaeus)
*Sarpa salpa* (Linnaeus)
*Boopsoidea inornata* Castlenau
*Spondyliosoma emarginatum* (Cuvier)
*Pagellus natalensis* Steindachner

Most of the popular angling fish belong to this family. It is therefore perhaps rather an important finding that these fish are of very little importance in the diet of otters, and those few eaten are mostly juveniles.

By far the most important sparid taken was *Diplodus sargus*. Average weight taken, estimated from premaxillas, was 9,6 g (n = 28). As in the case of *Palunolepis*, remains of more than one individual were frequently present in a single spraint, although only 37 scores were made during 1977. Through weight analysis it was estimated that about 61 were actually represented by the 37 scores.

It was observed that, like *Palunolepis*, juveniles tended to concentrate in intertidal rock pools and small gullies. No remains of large *Diplodus* were ever found in spraints.

The rest of the Sparidae can all be regarded as incidental prey of no importance. All, or at least most of them, were juveniles.

Once the premaxilla and a few other head bones of a large dageraad, *Chrysoblephus cristiceps*, were found at an otter holt. This fish may originally have been caught by an angler and then taken by an otter, or it may have been caught by an otter itself. Otters do seem to catch large fish occassionally, as several of the unidentified remains of fish obviously came from rather large fish. It is suspected however, that most of these were Serranids rather than Sparids. A few of the local anglers and a game ranger reported having seen otters catching large fish.

Family Pomadasyidae

Two scores were made of Pomadasys olivaceus. For practical purposes this species could have been included in the discussion on sparids.

Suborder Mugiloidea

Family Mugilidae

Liza richardsoni ?

According to Marais (1977) Liza richardsoni is the most common species along the Southern Cape coast. Ten mullets collected in Area 3 were identified as this species, although they could possibly have been Mugil cephalus.

Identification of remains up to species level proved to be impossible and Liza richardsoni was assumed. The actual species taken was of no importance, however, as only 14 were scored throughout 1977. If anything, this possibly indicates that otters do not spend much time hunting in estuaries.

A tame otter preferred large mullets above anything else.

Unidentified fish

In 104 cases the remains of fish could not be identified. Many of these belonged to small fish, but in a few cases they obviously belonged to fairly large fish. It has already been mentioned that remains of a fairly large dageraad ( ±1 kg ?) were found at an otter holt. Although Aonyx usually eats fish head first (Rowe-Rowe 1977 b), it was observed that a tame otter sometimes did not eat the head of large fish offered to it. As head bones were normally used for identification, identification of large fish would be very difficult if head bones had not been ingested. This may be the reason why no large fish could be identified. On the other hand it is doubtful whether any of the fish eaten were larger than about 1 kg. What is remarkable, is that scales were present in very few cases. This perhaps suggests that a number of these fish may have been remains left by anglers.

Of the 104 scores of unidentified fish, not more than about 20 were large fish. On a numerical basis therefore, they were not important, but they may have constituted up to about 2% of the total biomass consumed by otters.

Other items

Frogs were eaten very occassionally. As with Potamon, these were probably only caught while moving towards the sea. Six water beetles were recorded in 1977. Because of their small size, these most probably originated from the stomachs of frogs.

Remains of two pill millipedes (Glomerulus sp.) were identified. These were probably taken during play or by accident, as they were very common on land.

Seven scores were made of items completely unidentifiable.

Seaweed of the red coralline type was occassionally found in very small quantities. It was assumed that this was ingested accidentally while catching animals or through the stomachs of prey animals. Algae were often still attached to Gastropod shells. Tayler (1970) mentions Aonyx eating green seaweed, but no remains of this were found, nor were otters ever observed eating seaweed.

RELATIVE IMPORTANCE OF PREY ITEMS : A DISCUSSION ON TECHNIQUES OF ANALYSIS

The easiest, most common method of faecal analysis is that of frequency analysis. Two ways of expressing this are usually used, viz.

1. (Number of occurrences/Number of scats) x 100 = Percentage frequency
2. (Number of occurrences/Total number of occurrences) x 100 = Relative percentage frequency

As a quick, easy method of determining the feeding trends of a species, this method is probably adequate, as it has been proved to give a reasonably accurate account of food eaten in a few cases (Scott 1941, Erlinge 1968a). Many of the studies carried out had this purpose in mind.

This method has certain drawbacks, and when a detailed investigation into feeding habits of a species is attempted, these may be of a serious nature. Some authors recognised these drawbacks (e.g. Englund 1965, Jenkins et al. 1979), while others did not.

It is commonly realised that prey items with a large proportion of indigestible parts tend to be over-represented in scats (Lagler and Ostenson 1942, Stephens 1957, Knudsen and Hale 1968). According to Englund (1965), the more a certain kind of prey is exploited, the more often cases occur where scats contain remains of two, three of many specimens. In other words, the frequency of scats with the particular prey animal increases slower than does the total volume of the animal exploited. Jenkins et al. (1979) pointed out that items occurring frequently, but in small amounts, are over-estimated, while those occurring occassionally, but in large amounts, are under-estimated.

Frequency analysis was carried out in this study on the spraints of the whole of 1977 as one method of representing the relative importance of prey items (Table 14). The results of 1978 were not included in this to eliminate any possible seasonal bias. These results may serve as basis for discussion.

Two important deficiencies emerge from the discussions of the three authors mentioned previously, and from the present study. Frequency analysis assumes that the ratio live weight : weight of undigestible parts is constant for all prey items, and secondly that each score represents one prey animal.

When only fish are eaten, the first assumption is probably reasonably accurate, although some difference in ratio will be present between different species, and between small fish and large fish (Watson 1978). When, as in the case of the present study, the diet of a species is varied, this assumption is bound to be completely wrong. Ratios for the most important prey categories in this study were determined (Table 13). It was calculated that for clinids the ratio was about four times higher than for crabs. Sample sizes were small, but the large difference is obvious. Between different species of fish there was also some difference, but not nearly as much.

TABLE 13

Ratios of live weight : dry weight of hard parts of the main prey categories of *Aonyx capensis*.

| Category | Ratio used | Determined for | n |
|---|---|---|---|
| Crabs | 5 : 1 | *Plagusia chabrus* | 4 |
| *Chorisochismus dentex* | 16,7: 1 | *Chorisochismus* | 4 |
| Clinidae | 21 : 1 | *Clinus cottoides* | 2 |
| Other fish | 18,5: 1 | *Palunolepis brachydactylus* | 1 |
| | | *Sparodon durbanensis* | 1 |
| | | *Diplodus sargus* | 1 |

The assumption that each score represents an individual eaten may be true in some cases, but in others it is definitely not. In this study, remains of *Plagusia chabrus* occurred in about 94% of all spraints, but evidence of more than one individual eaten per spraint was very common - the phenomenon mentioned by Englund (1965). Even if all spraints contained remains of *Plagusia*, only a maximum percentage frequency of 100 would have been possible. *Cyclograpsus punctatus* however, had a much lower percentage frequency (35%), but the same situation was present. In many cases where a score was made, remains of more than a single individual were present. The other typical examples are those of Palunolepis brachydactylus and Diplodus sargus. Both these fish were only scored occasionally, but when they were scored, remains of more than one fish were often in evidence. In these cases the behaviour of otters is probably the cause. As mentioned before, these fish are probably occasionally cornered in small pools and then eaten in numbers at a time.

Another important disadvantage of frequency analysis is that the size of prey items is not taken into account. In most accounts of frequency analysis reference is made to the "importance" of prey items, without mention of the specific meaning of the word in these cases. It can only refer to number of prey items eaten. Numbers only however, do not necessarily indicate importance. Plagusia chabrus was estimated to make up about 27,9% of all organisms caught by otters according to frequency analysis. Average weight was estimated at 14,2 g. The product of these two figures would be 396. A relative percentage frequency of 7,4% was calculated for Octopus granulatus, while average weight was estimated at 138,2 g. The product of these two would be 1023. The increased importance of Octopus on a weight basis now becomes apparent. As will be shown later, numbers of Plagusia were heavily under-estimated by frequency analysis. After allowing for this error, it was estimated that the total weight of Octopus eaten, was about 94% of that of Plagusia eaten. Furthermore, if the fact that only about 34% of the live weight of crabs consists of soft parts is taken into account (Turnbull-Kemp 1960), while Octopus has very few undigestible parts, the importance of Octopus may well be higher than that of Plagusia.

Some authors have recognised the need for information on the contribution of prey items to volume or weight of prey ingested (e.g. Englund 1965, Knudsen and Hale 1968, Jenkins et al. 1979). Some form of bulk analysis was usually attempted by these authors in addition to frequency analysis.

Bulk analysis in itself is subject to a lot of error. Overestimation of prey items with a high proportion of hard parts is even worse than that of frequency analysis (Lagler and Ostenson 1942, Erlinge 1969). The second error of frequency analysis, that the frequency of scats with a particular prey item increases more slowly than the total volume of the animal ingested, is not present in bulk analysis. Once again however, no account is taken of size of prey eaten. On the whole, therefore, bulk analysis is probably still less accurate than frequency analysis.

In this study, volume of the different prey items in spraints was estimated and then converted to weight by means of conversion factors. When this weight was used as basis of expression (Table 15), only three prey species appeared to be of any significance, viz. *Plagusia chabrus* (73,5%), *Cyclograpsus punctatus* (11,9%) and *Chorisochismus dentex* (6,5%). Remains of these three species made up about 92% of the total weight of all spraints of 1977, in contrast to the 55% relative percentage frequency. *Octopus* was not included in this analysis, because of the extremely low volume and weight of beaks, but the value would have been in the order of 0,1%. It is obvious then that bulk-weight analysis as such is very much inferior to frequency analysis as an indicator of the importance of the prey of otters.

After certain correction factors had been applied to the results of bulk-weight analysis, the results changed significantly. The ratios live weight : weight of hard parts of the different prey categories (Table 13) were multiplied with the estimated total weight of remains in spraints. The ratio of *Plagusia* was used for *Cyclograpsus* too, while the ratio 18,5 : 1 was used for all fish escept *Chorisochismus* and the Clinidae. The result of this conversion gave estimated live weight represented by the spraints of 1977. Where average weight taken was known (estimated from remains in spraints before), estimated live weight was divided by this to give estimated number taken.

Volume of remains of prey items in spraints was estimated by spreading the dry spraints out on a flat surface. Different prey items were then more or less separated and an imaginary grid placed over the spraint. This method was regarded as fairly accurate for remains occurring in large amounts down to about 3% of the total volume. Volumes of remains lower than this were more and more difficult to estimate. To distinguish between 10 and 20% was easy, but to distinguish between 0,1% and 0,5% was very difficult.

Consequently high estimates are bound to be more accurate than low estimates.

Comparison between the two methods of analysis clearly shows the advantages and disadvantages. The bulk-weight estimate of number of Plagusia taken, was nearly three times as high as the frequency estimate, while that of Cyclograpsus was more than five times higher. This corresponds with the fact that frequently up to 16 premaxillas of Cyclograpsus (left and right) were found in a single spraint. It is evident that frequency analysis seriously underestimated the importance of these two species.

Remains of Chorisochismus indicated more than one individual in a number of spraints, but not nearly in such large numbers as crabs. The estimate of bulk-weight analysis was slightly higher than that of frequency analysis, and was once again regarded as the more accurate estimate. In the case of Clinus cottoides, Clinus superciliosus and unidentified Clinidae, the two estimates were remarkably similar. For all other fish, except Palunolepis and Diplodus, the results of frequency analysis were assumed to be more accurate than those of bulk-weight analysis. In a few cases only a frequency analysis estimate was available. Palunolepis and Diplodus, as mentioned before, were frequently caught in numbers at a time. As in both cases the bulk-weight estimate was the highest, this was assumed to be the more accurate one. The discrepancy between the two estimates of Blennius cornutus can be explained by the high frequency of very few remains in spraints. A possible explanation for the low volumes may be that part of the remains of Blennius were actually identified as Clinidae, as only a few specific bones could easily be distinguished. The frequency estimate was probably the more accurate.

From the above discussion it becomes apparent that in some cases bulk-weight analysis was more accurate, while in other cases frequency analysis was more accurate. The two methods have the same basis of expression, i.e., estimated number of prey animals eaten represented by the 1129 spraints of 1977. To obtain a final estimate of relative numbers taken, therefore, the results of these two methods have been combined (Table 16). The most accurate estimate was taken for each prey item, as indicated in the previous paragraph. Although 280 scores were made of Octopus, 295 beaks were actually found (in 15 spraints two beaks were found). This number was used for Octopus.

In cases where average weight taken had been estimated, this estimate was multiplied with estimated number taken to arrive at estimated weight taken. In other cases the estimated of bulk-weight analysis was used for this purpose.

Of more than 36 different animals recorded in the diet of otters, only four now appear to be of any significance. About 42% of the numbers or 36% of the biomass was accounted for by Plagusia chabrus. Although Octopus granulatus accounted for only about 4% of the numbers, they constituted about 34% of the biomass eaten by otters. Octopus could therefore be ranked as second in importance. Together these two species made up nearly 70% of the biomass eaten.

The two other organisms of importance are Chorisochismus dentex and Cyclograpsus punctatus. About 26% of all organisms eaten were estimated to be Cyclograpsus. Because of their small size however, contribution to biomass was only about 6%. Furthermore it has a high proportion of indigestible parts. From a nutritional point of view therefore, it can not be as important as Chorisochismus, contributing about 9 and 11% to numbers and biomass respectively.

The remaining 14% of the biomass consisted mainly of the other 27+ species of fish.

TABLE 14

Frequency analysis : Total for January 1977 - December 1977

| Category | Total Scores | % Frequency | Rel. % Frequency |
|---|---|---|---|
| Plagusia chabrus | 1 056 | 93,5 | 27,9 |
| Cyclograpsus punctatus | 395 | 35,0 | 10,4 |
| Jasus lalandii | 25 | 2,2 | 0,7 |
| Potamon perlatus | 23 | 2,0 | 0,6 |
| Palaemon sp. | 4 | 0,4 | 0,1 |
| Other Crustacea | 2 | 0,2 | 0,1 |
| Chorisochismus dentex | 624 | 55,3 | 16,5 |
| Apletodon knysnaensis | 1 | 0,1 | 0,03 |
| Clinus cottoides | 165 | 14,6 | 4,4 |
| Clinus superciliosus | 53 | 4,7 | 1,4 |
| Clinus capensis | 54 | 4,8 | 1,4 |
| Clinus anguillaris | 1 | 0,1 | 0,03 |
| Pavoclinus graminis | 32 | 2,8 | 0,9 |
| Pavoclinus pavo | 3 | 0,3 | 0,1 |
| Clinus taurus | 2 | 0,2 | 0,1 |
| Unidentified Clinidae | 326 | 28,9 | 8,6 |
| Blennius cornutus | 258 | 22,9 | 6,8 |
| Blennius fascigula | 11 | 1,0 | 0,3 |
| Gobius nudiceps | 79 | 7,0 | 2,1 |
| Acanthistius sebastoides | 30 | 2,7 | 0,8 |
| Epinephelus guaza | 7 | 0,6 | 0,2 |
| Epinephelus andersoni | 1 | 0,1 | 0,03 |
| Unidentified Serranidae | 14 | 1,2 | 0,4 |
| Palunolepis brachydactylus | 68 | 6,0 | 1,8 |
| Cheilodactylus fasciatus | 31 | 2,7 | 0,8 |
| Diplodus sargus | 37 | 3,3 | 1,0 |
| Sparadon durbanensis | 8 | 0,7 | 0,2 |
| Rhabdosargus tricuspidens | 11 | 1,0 | 0,3 |
| Lithognathus mormyrus | 4 | 0,4 | 0,1 |
| Sarpa salpa | 6 | 0,5 | 0,2 |
| Boopsoidea inornata | 4 | 0,4 | 0,1 |
| Spondyliosoma emarginatum | 2 | 0,2 | 0,1 |
| Pagellus natalensis | 1 | 0,1 | 0,03 |
| Unidentified Sparidae | 18 | 1,6 | 0,5 |
| Pomadasys olivaceus | 2 | 0,2 | 0,1 |
| Liza richardsoni (?) | 14 | 1,2 | 0,4 |
| Unidentified Pisces | 104 | 9,2 | 2,8 |
| Octopus granulatus | 280 | 24,8 | 7,4 |
| Sepia tuberculata | 4 | 0,4 | 0,1 |
| Anura | 8 | 0,7 | 0,2 |
| Water beetle | 6 | 0,5 | 0,2 |
| Pill millipede | 2 | 0,2 | 0,1 |
| Unidentified | 7 | 0,6 | 0,2 |

TABLE 15

Composition by weight of spraints January 1977 to December 1977, and conversion to estimated live weight and numbers eaten (see text for explanation).

| Category | Total weight in spraints (g) | % | Estimated live weight (g) | Estimated number |
|---|---|---|---|---|
| Plagusia chabrus | 8669,25 | 73,50 | 43345,5 | 3413 |
| Cyclograpsus punctatus | 1046,6 | 11,90 | 7033,0 | 2069 |
| Chorisochismus dentex | 769,4 | 6,53 | 12849,0 | 743 |
| Clinus cottoides | 30,2 | 0,26 | 637,2 | 199 |
| Clinus superciliosus | 23,9 | 0,20 | 504,3 | 57 |
| Clinus capensis | 11,0 | 0,09 | 232,1 | 17 |
| Pavoclinus graminis | 3,1 | 0,03 | 65,4 | 12 |
| Clinus taurus | 0,5 | – | 10,6 | 2 |
| Unidentified Clinidae | 65,5 | 0,56 | 1382,1 | 346 |
| Blennius cornutus | 45,5 | 0,39 | 960,1 | 123 |
| Palunolepis brachydactylus | 48,8 | 0,41 | 902,8 | 100 |
| Gobius nudiceps (?) | 10,8 | 0,09 | 227,9 | 79 |
| Acanthistius sebastoides | 60,0 | 0,51 | 1200,0 | 34 |
| Epinephelus guaza | 33,0 | 0,28 | 660,0 | 19 |
| Epinephelus andersoni | 2,2 | 0,02 | 44,0 | – |
| Unidentified Serranidae | 61,0 | 0,52 | 1220,0 | – |
| Cheilodactylus fasciatus | 11,2 | 0,09 | 207,2 | 17 |
| Diplodus sargus | 31,4 | 0,27 | 580,9 | 61 |
| Sparodon durbanensis | 7,7 | 0,06 | 140,6 | 7 |
| Rhabdosargus tricuspidens | 10,1 | 0,09 | 186,9 | 10 |
| Lithognathus mormyrus | 5,3 | 0,04 | 98,1 | 5 |
| Sarpa salpa | 10,3 | 0,09 | 190,6 | 14 |
| Unidentified Sparidae | 16,6 | 0,14 | 307,1 | 22 |
| Spondyliosoma emarginatum | 0,9 | 0,01 | 16,7 | 1 |
| Pomadasys olivaceus | 3,2 | 0,03 | 59,2 | 3 |
| Liza richardsoni (?) | 17,6 | 0,15 | 325,6 | – |
| Unidentified Pisces | 188,4 | 1,60 | 3485,4 | – |
| Jasus lalandii | 135,8 | 1,15 | 679,0 | – |
| Potamon perlatus | 22,3 | 0,19 | 111,2 | – |
| Anura | 7,3 | 0,06 | – | – |
| Palaemon & Unidentified Crustacea | 0,6 | 0,01 | 3,1 | – |
| Unidentified | 7,4 | 0,06 | – | – |
| (Shelled Mollusca) | (47,6) | (0,41) | – | – |
| (Fish scales only) | ( 9,8) | (0,08) | – | – |
| TOTAL | 11788,5 | | 77665,6 | |

TABLE 16

Final estimate of number and weight of prey taken by otters January 1977 to December 1977, represented by 1129 spraints : combination of results of analysis by weight and frequency analysis.

| Category | Est. number | % | Est. weight (g) | % |
|---|---|---|---|---|
| Plagusia chabrus | 3413 | 42,3 | 43345,5 | 36,1 |
| Cyclogropsus punctatus | 2069 | 25,7 | 7033,0 | 5,9 |
| Jasus lalandii | 25 | 0,3 | 679,0 | 0,6 |
| Potamon perlatus | 23 | 0,3 | 111,15 | 0,1 |
| Other Crustacea | 6 | 0,1 | 10 | 0,01 |
| TOTAL Crustacea | 5536 | 68,7 | 51178,7 | 42,6 |
| Octopus granulatus | 295 | 3,7 | 40769 | 34,0 |
| Sepia tuberculata | 4 | 0,1 | 40 | 0,03 |
| TOTAL Mollusca | 299 | 3,8 | 40809 | 34,0 |
| Chorisochismus dentex | 743 | 9,2 | 12849,0 | 10,7 |
| Apletodon knysnaensis | 1 | 0,01 | 1 | 0 |
| Clinus cottoides | 199 | 2,5 | 637,2 | 0,5 |
| Clinus superciliosus | 57 | 0,7 | 504,3 | 0,4 |
| Clinus capensis | 54 | 0,7 | 745,2 | 0,6 |
| Clinus anguillaris | 1 | 0,01 | 10 | 0,01 |
| Pavoclinus graminis | 32 | 0,4 | 172,8 | 0,2 |
| Pavoclinus pavo | 3 | 0,04 | 6 | 0,01 |
| Clinus taurus | 2 | 0,03 | 10,6 | 0,01 |
| Unidentified Clinidae | 346 | 4,3 | 1382,1 | 1,2 |
| Total Clinidae | 696 | 8,6 | 3468,2 | 2,9 |
| Blennius cornutus | 258 | 3,2 | 2012,4 | 1,7 |
| Blennius fascigula | 11 | 0,1 | 64 | 0,1 |
| Total Blenniidae | 269 | 3,3 | 2076,4 | 1,7 |
| Gobius nudiceps | 79 | 1,0 | 679,4 | 0,6 |
| Acanthistius sebastoides | 34 | 0,4 | 1200,0 | 1,0 |
| Epinephelus guaza | 7 | 0,1 | 660,0 | 0,6 |
| Epinephelus andersoni | 1 | 0,01 | 44,0 | 0,04 |
| Unidentified Serranidae | 14 | 0,2 | 1220,0 | 1,1 |
| Total Serranidae | 56 | 0,7 | 2124,0 | 1,8 |
| Palunolepis brachydactylus | 100 | 1,2 | 902,8 | 0,8 |
| Cheilodactylus fasciatus | 31 | 0,4 | 372 | 0,3 |
| Total Cheilodactylidae | 131 | 1,6 | 1274,8 | 1,1 |
| Diplodus sargus | 61 | 0,8 | 580,9 | 0,5 |
| Sparadon durbanensis | 8 | 0,1 | 140,6 | 0,1 |
| Rhabdosargus tricuspidens | 11 | 0,1 | 186,9 | 0,2 |
| Lithognathus mormyrus | 4 | 0,1 | 98,1 | 0,1 |
| Sarpa salpa | 6 | 0,1 | 84 | 0,1 |
| Boopsoidea inornata | 4 | 0,1 | 50 | 0,04 |
| Spondyliosoma emarginatum | 2 | 0,03 | 16,7 | 0,01 |
| Pagellus natalensis | 1 | 0,01 | 15 | 0,01 |
| Unidentified Sparidae | 18 | 0,2 | 307,1 | 0,3 |
| Total Sparidae | 115 | 1,4 | 1479,3 | 1,2 |
| Pomadasys olivaceus | 2 | 0,03 | 59,2 | 0,1 |
| Liza richardsoni (?) | 14 | 0,2 | 325,6 | 0,3 |
| Unidentified Pisces | 104 | 1,3 | 3485,4 | 3,0 |
| TOTAL Pisces | 2273 | 28,2 | 27822,3 | 23,2 |
| Anura | 8 | 0,1 | 200 | 0,2 |
| Water Beetle | 6 | 0,1 | 12 | 0,01 |
| Pill Millipede | 2 | 0,03 | 10 | 0,01 |
| Unidentified | 7 | 0,1 | - | - |
| TOTAL | 8066 | | 120032,0 | |

## FORAGING BEHAVIOUR

Although otters were frequently observed foraging, actual behaviour under water was impossible to observe. The only time that detail could be observed, was when a female with her cub was feeling under stones in very shallow water and located and caught *Cyclograpsus* in this way.

Hunting was nearly always along rocky ridges, frequently in very turbulent water. Every time that hunting was observed it appeared to be fairly intensive, the dives following one another at short intervals. Play was rarely observed in the sea, although otters sometimes appeared to enjoy the wave action. Forty-five dives timed ranged from 16 to 41 seconds, with an average of 25. No distinction was made between successful and unsuccessful dives, as it was often impossible to tell whether an otter was eating or not. Most dives however, appeared to be successful.

Rowe-Rowe (1977 b) observed a range of 8 to 26 s, with a mean of 17,4 s. It would appear therefore, that more hunting effort is required in the sea than in fresh water. This might well be expected from the turbulence of the water. The dives timed by Watson (1978) and Kruuk and Hewson (1978) on *Lutra lutra* were 28,4 s and 24,8 s on average respectively, which is very near that of *Aonyx* in this study. Watson's (1978) range was 5 to 45 s.

Hunting was seldom observed beyond the last ridge of rocks, or at least beyond the surf line. *Aonyx* apparently prefers to hunt in fairly shallow water, just as *Lutra lutra* does on the Scottish coast. (Kruuk and Hewson 1978, Watson 1978). A one year old tame otter kept by Maxwell (1960), although fully capable, was very reluctant to dive in deep water.

Most items caught were eaten while the otter trod water, with the head held far back to facilitate swallowing. The forefeet were frequently used to hold prey and to feed it into the mouth. Occassionally, when a large crab or fish was caught, an otter would move on to exposed rocks to finish eating. Once an otter was seen to catch a large *Clinus superciliosus*, swim around leasurely while chewing all the time, and then move onto exposed rocks to finish eating. Time spent out of the water on exposed rocks varied between about two and ten minutes. Taking large items to the shore to devour appears to be common practice of Aonyx (Kingdon 1977, Rowe-Rowe 1977 b).

Only once was an otter seen to go on land while eating. In this case it had a large crab in its mouth. The crab was caught fairly far offshore (± 20 m). After catching it, the otter moved leisurely towards land, then walked to the nearest fresh water pool. This area was a well-known holt. The crab was eaten inside the water, while the otter occassionally drank water in between. After it had eaten, it apparently smelled me, turned around and saw me, and after a short confrontation departed into the bush.

The above mentioned incident, together with the fact that holts were apparently always situated at fresh water, gave rise to the hypothesis that the otters along the coast are dependent on fresh water for drinking purposes. They have been reported from areas along the coast where no streams exist (Fitzsimmons 1919, Shortridge 1934), but this is regarded as unlikely. Aonyx capensis is known to travel vast distances (Maxwell 1960, Tayler 1970), and it may well be possible that some form of fresh water did exist within reach of otters seen by these authors. Any form of fresh water, not necessarily streams, would be suitable.

As mentioned previously, a female with her cub was once seen to hunt in very shallow, quiet water by feeling underneath rocks. At least one Cyclograpsus was caught this way. Although no actual hunting was observed, this same female had previously been seen moving around with two previous cubs in typical Cyclograpsus habitat, i.e. loose rocks and shallow rock pools in the Littorina zone.

Whenever adult otters were observed leaving or returning to the holt, they always moved straight towards or from the open sea, in other words bypassing the Cyclograpsus zone. It is however, strongly suspected that the same method of hunting, i.e., feeling under stones, in cracks, etc. is used in deeper water. Inland clawless otters use their forefeet to feel in mud and under stones to locate crabs and frogs (Ewer 1973, Kingdon 1977, Rowe-Rowe 1977 b). The tame otter was also observed doing this.

The tame otter was occassionally observed to dig for fresh water crabs, after apparently smelling them from above the ground. In some cases it was successful, in others not. A very good sense of smell is apparently indicated.

Rowe-Rowe (1977 c), was of the opinion that Aonyx hunts by sight as well as feel. Feeling behaviour was actually observed, while reliance on sight was deduced from the fact that hunting efficiency for fish was lower in murky water than in clear water. He observed no difference in efficiency of hunting crabs and frogs.

On the southern Cape coast, sight is probably of little importance in hunting. The white surf in which hunting is normally done, limits visibility virtually to zero. It is suggested that the extremely well developed whiskers may be important in locating and following prey. In the European otter Lutra lutra it has been found that the whiskers are highly innervated, indicating the importance of these as a sensory mechanism (Harris 1968). Clawless otters that were seen to walk in shallow water moving their heads from side to side just below the surface (Rowe-Rowe 1977 b), may also have done this specifically to bring their whiskers into play, although of course sight would also improve with the eyes under water. Moreover, Bruton (1977) found that moving the head from side to side was a common method of hunting in the barbel Clarias gariepinus, a predatory omnivorous fish relying to a large extent on its whiskers for detection of prey.

No evidence of Tayler's (1970) statement that otters move inland during stormy periods to feed in fresh water, was found. Even a female with cubs refused to do so during a heavy storm in May 1977. In this case they apparently stayed in the holt for about two days. When the storm did not abate, they were probably forced by hunger to enter the sea, although there was nothing preventing them from hunting in streams. One of the cubs subsequently died, apparently from exhaustion. Spraints collected the following morning, had a very high percentage of Octopus suckers. The staff of the Park reported that otters were frequently seen during the daytime in stormy seas in winter.

No evidence of tool using behaviour was found, although Donnelly and Grobler (1976) reported the use of stones to crush mussels. This was during an extremely severe drought, and the authors admit that this was not normal behaviour. It does indicate their adaptability, however.

There is little agreement on the time that Aonyx capensis is most active. Fitzsimmons (1919) regards them as mainly nocturnal, whereas Smithers (1971) found a lot of diurnal activity. Rowe-Rowe (1977b) regards them as predominantly crepuscular.

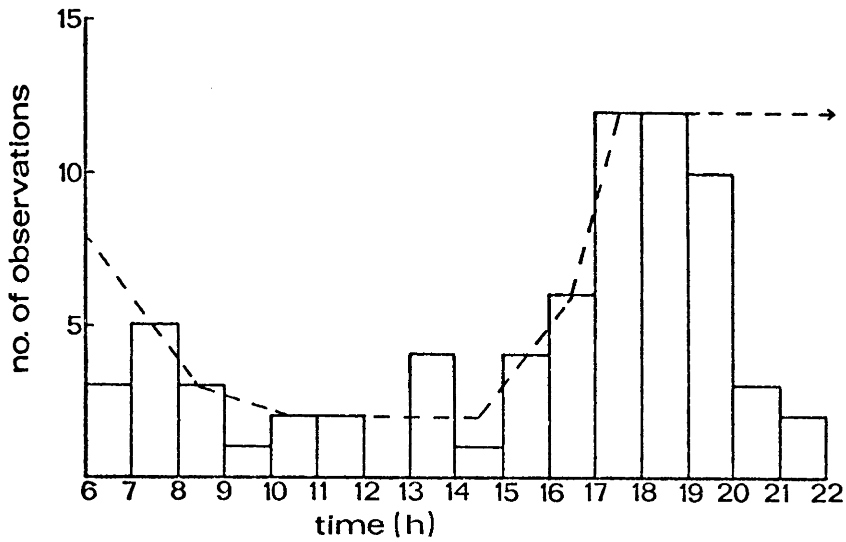



Fig. 38 Activity pattern of otters. Actual observations (histogram) and suggested pattern.

Most of the otters observed during the study period by myself and tourists, were seen between about 16 h 00 and 20 h 00, with a peak of activity between 17 h 00 and 19 h 00 (Figure 38). Few otters were seen during the main daylight hours. The results of Figure 38 are somewhat biased however, and a suggested modification has been added. Time spent along the coast by myself between 06 h 00 and 07 h 00 was much less than during the rest of the day, while a fairly high proportion of time along the coast was spent between 17 h 00 and 20 h 00. After this it was too dark to see anything, and records after this time were mainly deduced from tracks. The same general activity pattern was assumed for tourists walking the otter trail. It was therefore assumed that otter activity was higher during the early morning hours than recorded. What happened between sunset and sunrise was not possible to determine, but most of the activity was during this period. Nearly all the tracks in the sandy gully at Goudgate were made during the night, many of them after 22 h 00. Many sight records were obtained from non-white game rangers, but these were not accompanied by exact times. It appeared, however, that they were mostly early in the morning and late in the afternoon, and also at night.

Tide apparently had little influence on the times of activity of otters. Correlation between time of activity and length of time to the next high tide yielded a coefficient of 0,124. In Scotland, *Lutra lutra* apparently had a slight preference for low tides, but this was not marked, although hunting appeared to be more successful at low tide (Watson, 1978).

EFFECTS OF OTTERPREDATION ON PREY POPULATIONS

To estimate in what numbers prey animals are taken, the following has to be known :

1. Total food requirement of an average otter.
2. Population size of otters along the coast.
3. Ratio in which different prey animals are taken.

An attempt was made to determine the food requirements of otters accurately. So many variables are involved, and such an elaborate experimental system, with its inherent errors, is required, that this was not deemed worthwhile (Erasmus* pers. comm., Fairall+ pers. comm., Van Aarde 1977). However, a few rough determinations were made to get some idea of the amount of food needed.

A wild female otter of 12 kg was kept in the trap for two days. The trap was placed in the shade. During the two days she ate 1,2 kg and 1,4 kg of fish respectively, drinking a lot of water at the same time. The otter was fairly active inside the trap, trying to get out. She was probably under considerable stress. At the end of two days she appeared to have lost some weight.

An estimate of 1,3 kg of fish per day was obtained from the above experiment. The crudity of this was apparent. Confinement to a small cage may have reduced energy expenditure, but on the other hand stress may have increased it.

Food intake of the tame otter was checked on two days, without disturbing his normal routine. This otter was about 10 months old. On both days 1,2 kg of large fish was eaten. On the first day an additional five crabs, one rocksucker and one slice of bread was eaten, while on the second day an additional five crabs, three slices of bread and about 35 clawed frogs were consumed. The frogs were all fairly small and together probably weighed less than 1 kg. Average consumption for these two days was estimated to be about 1,8 kg.

Duplaix-Hall (1975) stated that otters in general consume about 20 to 24% of their bodyweight daily. For an otter of 13 kg, this would mean 2,6 to 3,1 kg of food. Van Wijngaarden and van de Peppel (1970)

*Prof. T Erasmus, Department of Zoology, University of Port Elizabeth

+Dr N Fairall, Mammal Research Institute, University of Pretoria estimated average daily consumption of Lutra lutra at 1 kg or more. Two $1\frac{1}{2}$ year old Lutra lutra kept by Stephens (1957) consumed an average of slightly less than 1 kg daily.

From the above, an estimate of 2 kg of food needed by an adult Aonyx daily, is probably not unrealistic. It is admittedly crude, and might vary considerably. Furthermore, an "average" otter probably does not exist. Age, condition, pregnancy, lactation etc. all effect daily food consumption. It is likely to be more than at least 1,3 kg, the lowest estimate for both the wild and tame otter. On the other hand it may probably be up to 3 or even 4 kg, especially as a greater mass of crabs than fish needs to be eaten to supply the same amount of digestible material. Although without any statistical proof, therefore, the minimum amount of food required by an "average" otter of 13 kg (average weight of nine otters) is estimated to be about 2 kg.

The population size of otters is estimated in a later chapter at about 33 otters along the coast of about 60 km (straight-line distance).

The ratios between prey animals were estimated before.

From previous estimates yearly consumption of one otter would be a minimum of about 730 kg. A population of 33 otters would then consume at least about 24 090 kg (402 kg/km) of food. Estimated weight and numbers of different prey categories taken per kilometre of coastline, are to be found in Table 17.

The results of Table 17 are meant as crude estimates. They may be rejected by those who regard them as unreliable. The purpose of this section was to provide some form of estimate, if ever this may be needed for management or other purposes.

One problem that remains, is that the biomass of prey animals available, is not known. The extremely heterogeneous inter- and subtidal areas will make estimation of this very difficult. Furthermore, to be able to assess the impact of otters on prey populations, various other factors, such as production of prey animals, other predators and other mortality factors etc., would have to be known. This is therefore not possible at this stage.

TABLE 17

Estimated minimum yearly weight and numbers of prey taken by otters per kilometre of coastline (straight-line distance) during 1977.

| PREY ITEM/CATEGORY | WEIGHT (kg) | NUMBERS |
|---|---|---|
| *Plagusia chabrus* | 145 | 10 211 |
| *Cyclograpsus punctatus* | 24 | 7 059 |
| *Octopus granulatus* | 137 | 991 |
| *Chorisochismus dentex* | 43 | 2 486 |
| Clinidae | 12 | 2 400 |
| Blenniidae | 7 | 907 |
| Gobiidae | 2 | 233 |
| Serranidae | 7 | 185 |
| Cheilodactylidae | 4 | 411 |
| Sparidae | 5 | 389 |
| Other fish | 14 | 434 |
| TOTAL | 400 | 25 706 |

# DISCUSSION AND CONCLUSION

Due to the results of several studies on Lutra lutra and Lutra canadensis, otters in general have become known as predominantly fish-eaters, although their adaptability towards other diets has also been shown. The various studies on these otters have been summarised by Harris (1968).

In Africa conflicting opinions about the food of Aonyx capensis existed. In some areas this otter apparently subsists on crabs (Turnbull-Kemp 1960), while in other areas, they have been reported to subsist on various other animals, such as mammals and birds, in addition to crabs and fish. Some trout farmers and anglers believe these otters are guilty of eating large amounts of fish.

Rowe-Rowe (1977 a) showed that crabs were the most important prey of clawless otters in Natal, while other organisms, mainly frogs and fish, were also caught. The seasonal variation found in the relative importance of different prey items, indicated some adaptability.

Although birds and mammals were of virtually no importance in the diet of Natal otters (Rowe-Rowe 1977 a), and no remains of these were found in spraints at Tsitsikama at all, reports of otters catching rats, cane rats, waterfowl and poultry are common (Fitzsimmons 1919, Shortridge 1934, Bryden 1936, Dorst and Dandelot 1970). An otter watched by Venter (1969) was a regular raider of poultry.

Donnelly and Grobler (1976) reported large scale exploitation of fresh water mussels by Aonyx capensis during a severe drought in Rhodesia. For the first time the use of tools was reported by a species other than Enhydra lutris, the true sea otter. Stones were used to crush the shells of mussels.

From the previous discussion Aonyx capensis appears to be a euryphagous feeder. This may be correlated with its amphibious habits, although carnivores in general are regarded as essentially opportunistic in their feeding habits (Ewer 1973). Ability to capitalise on almost any food item in plentiful supply seems typical. A very good example of this was shown by Randall (1977) in his study on civets.

The present study showed that the feeding habits of Aonyx capensis are not essentially different from those of other carnivores. The ability to capitalise was shown very clearly by the importance of Octopus in the diet. No comparable animal exists in fresh water, the normal habitat of Aonyx, but the abundance and catchability of this mollusc was effectively exploited.

The predominance of small fish in the diet of otters at Tsitsikama, but also inland, (Ewer 1973, Rowe-Rowe 1977 a) is noteworthy. This may be related to two points. The teeth of Aonyx are essentially adapted for crushing and the carnassial shearing apparatus is very poorly developed (Rowe-Rowe 1977 a). Small fish would probably be easier to eat than large fish, as they can just be chewed and swallowed. Another reason may just be that small fish are easier to catch than large fish, as body length is one of the factors determining the speed of fish (Nikolsky 1963). Aonyx is probably not such a fast swimmer as Lutra maculicollis, a species which subsists more on fish and takes larger fish than Aonyx (Rowe-Rowe 1977 a).

From several points of view, a great similarity exists between Aonyx capensis and the true sea otter Enhydra lutris. Both species have well developed molars and premolars adapted for crushing, while the carnassials are also highly molarised (Fisher 1941, Ewer 1973). Furthermore tactile discrimination by the forefeet as in the case of Aonyx, appears to be highly developed in sea otters (Kenyon 1969). Enhydra apparently prefers to hunt somewhat deeper than Aonyx (depths of 10 to 25 m), but it is still littoral (Kenyon 1969).

Despite the similarities between the two species, their food differs to a large extent. Barabash-Nikiforov (1935, 1969), studying sea otters in the Commander Islands, found that sea urchins formed 59% of the total spraint volume, the rest being made up of 23,3% Molluscs (mainly Gastropods and Pelecypods), 10% crabs and 6,7% fish. Octopuses were also seen to be eaten. On Amchitka island, however, stomach contents showed that 50% of the food volume was made up by fish, while molluscs and echinoderms accounted for 37% and 11%

respectively. Spraint analysis from the same area, expressed as percentage frequency, resulted in 95% echinoderms, 46% molluscs and 15% fish (Kenyon 1969). The principal food of Californian sea otters appears to be the abalone (Haliotis rufescens), a species not present in the northern habitats (Fisher 1939, Limbaugh 1961).

Estes, Smith and Palmisano (1978) found good evidence that the importance of sea urchins in the diet of sea otters is directly dependent on the density of the urchins, which in turn is influenced by the density of otters. They therefore suggest that the partial shift in diet from echinoderms to fish in the Aleutian Islands was the result of an increase in population size of the otters. Sea otters are apparently fairly adaptable in their feeding habits.

The possibility of a similar community structure as that mentioned by Estes et al. (1978) existing along the southern Cape coast cannot be excluded. It has been mentioned that Aonyx capensis feeds mainly on crabs inland, but that along the coast far more fish, and also octopi, are taken. It could be that otterpredation keeps the number of Plagusia down, thereby enforcing a shift in diet towards other prey. Only a quantitative study on the ecology of Plagusia, especially turnover rate, could elucidate this.

If Aonyx and Enhydra are so similar, why does Aonyx not catch Echinoderms or Gastropod and Pelecypod Molluscs? The answer can only be speculated on. One reason may be that Aonyx is still in an early stage of adaptation to a marine life. For perhaps millions of years it has been catching mobile prey in fresh water. Along the Tsitsikama coast this kind of prey is abundant, perhaps more so than inland. There was therefore no need to adapt to a completely different kind of prey.

Enhydra is truly adapted to a marine existence (Ewer 1973, Estes et al. 1979). It very seldom moves to land. The ancestral (presumed) terrestrial form of this species may have taken directly to a marine existence without an intermediary fresh water form. During this transition the adaptation towards a more omnivorous diet (from a strictly flesh-eating diet) may have occurred. The teeth of

Enhydra are more molarised than those of Aonyx (Ewer 1973), indicating perhaps more extreme adaptation towards an omnivorous diet.

In summary then, Aonyx capensis appears to be essentially an opportunistic feeder. It has been shown to be very adaptable, even to the extent of using tools. If given the choice however, it appears to prefer crabs, for which the teeth are very well adapted. Crabs are very abundant along the Cape coast, and so are fish and octopuses. Aonyx capitalised on this and caught more or less what was most abundant and the easiest to catch. The abundance of its preferred prey made heavy predation on less preferred items unnecessary.

The dependence on fresh water indicates that adaptation towards a marine existence is not complete. The abundance of fresh water along the Tsitsikama coast, however, made habitation of this area possible.

The reason for the abundance of Aonyx capensis along the Tsitsikama coast is most probably a combination of the abundance of preferred food, the freely available fresh water supply and ample shelter.

# CAPTURE, IMMOBILIZATION AND MARKING

## INTRODUCTION

The live-trapping of African otters is notoriously difficult (Smithers *pers. comm.*), and the absence of reports in the literature suggests that this is the case with other otters as well. An exception was the success of Northcott and Slade (1976), who used a specialised technique to capture *Lutra canadensis* in a marine habitat.

As individual otters were impossible to distinguish from one another from their natural markings, the only way to identify them was to mark them artificially. This could only be done after trapping them.

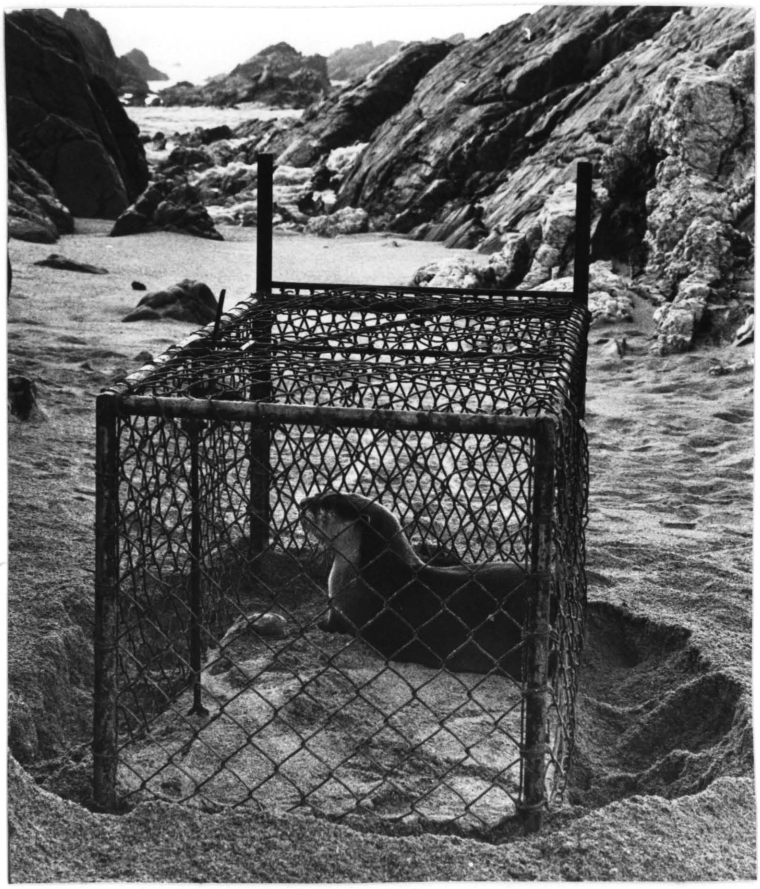
The otters along the Tsitsikama coast had been protected for about 10 years, and before that had probably never been subject to trapping. It was therefore regarded worthwhile to try to capture them.

## MATERIALS AND METHODS

Most otters were caught by means of standard caracal traps (Figure 39). Three of these traps, two with single doors and one with two doors, were borrowed from the Cape Provincial Administration Division of Nature Conservation until September 1977, while another one, also with one door, was borrowed from National Parks Board during the whole study period.

During October two additional traps were constructed from aluminium and welded mesh (Figure 39), the main purpose being to make light traps for carrying up and down the escarpment,as most areas were not accessible by motor vehicle. A device was attached to these traps to prevent the otter opening the door, as it was very light. The trap was activated when an otter took bait which was tied to a treadle.

Fish were normally used as bait. Crabs were tried as bait, but with no success. When spraints were put in traps to lure otters, the trap was sometimes full of urine and faeces on the outside, but no otter ventured inside. In other cases otters showed no interest. No a



b

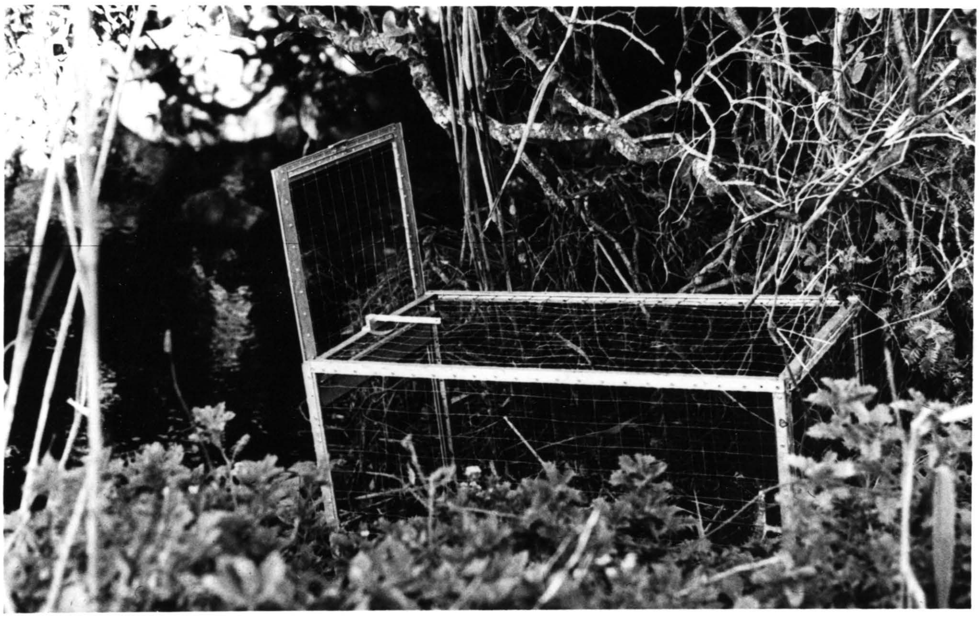


Fig. 39 The two types of traps used during the study.

(a) Standard caracal trap in the sandy gully at Goudgate (Fig. 41).

(b) Light-weight home-made trap set along a stream in a holt (Holt 9, Fig. 41).

effort was made to conceal traps, as this did not prove necessary.

Most trapping was carried out in the sandy gully at Goudgate (Figure 39), which otters frequently crossed, while traps were also set at eight different holts. Traps were always set late in the afternoon or in the evening and checked the next morning.

When an otter had been captured, it was gradually forced to one side by means of poles stuck through the sides of the trap. Phencyclidine hydrochloride (Sernylan : Parke-Davis Laboratories, Isando) at a concentration of 100 mg/mℓ was twice used to immobilise otters, once in combination with acetopromazine (Parke-Davies Laboratories, Isando) (10 mg/mℓ). The tranquillizer reduced the undesirable side effects commonly associated with the use of the drug alone (Seal, Erickson and Mayo 1970, Ebedes 1973), but recovery time was extremely long. Ketamine Hydrochloride (Ketalar : Parke-Davies Laboratories, Isando) was preferred at a concentration of 100 mg/mℓ or 50 mg/mℓ. This drug was known to have a wide safety margin (Harthoorn 1973, Ramsden, Coppin and Johnston 1976), and was particularly well suited for use on carnivores (Smuts, Bryden, De Vos and Young 1973, Ramsden et al. 1976). Minor muscular convulsions were still apparent after the use of Ketalar, and to avoid this, use of the tranquillizer acetopromazine was once again combined with the drug. Azaperone proved to be very effective in the case of civets (Randall, 1977) and would probably have been just as effective for otters, but as acetopromazine was already available and the combination of Ketalar and acetopromazine had already been shown to be very effective for other mustelids (Ramsden et al. 1976), acetopromazine was used. The drug and tranquillizer were injected simultaneously intramuscularly into the thigh by means of a disposable 2,5 $cm^3$ syringe.

When a satisfactory state of anaesthesia had been attained, the otter was removed from the trap, measured and marked. All ectoparasites were collected. These were identified by J B Walker of the Veterinary Research Institute at Onderstepoort. Otters trapped within the main study area were usually taken to the laboratory, but those trapped at more remote holts were measured and marked in the field and then put back into the trap. About eight poles were usually left in the bush near such a trap, while other equipment was carried down the escarpment in a rucksack.

Animals in a state of catalepsy from Ketamine still respond to noxious stimuli, and the presence of such stimuli during the recovery phase has been warned against (Ramsden et al. 1976). After having worked with an otter, therefore, it was returned to the trap, which was then covered with a sail or vegetation or hidden beneath thick bush. While working with otters, their eyes were always protected against sunlight.

Several methods of marking were used. Coloured plastic markers were at first attached to one of the ears. A hole was punched through the cartilage through which a piece of nylon about 2 mm thick was pushed. The marker was inserted at one end and covered with a plastic washer, while another washer was inserted at the other side of the ear. The nylon was then melted at both ends (Figure 40). The first otter was marked by means of a fairly large fish tag which was also inserted through a hole in the ear. In this case a washer clipped into position at the other side of the ear.

Anticipating the possibility that these markers might be lost, and to facilitate identification in such cases, a very small numbered metal ear tag, which could not be lost, was clipped onto the ear below the plastic tag.

Later, after it became evident that plastic markers were unsatisfactory, a technique of freeze branding was employed. All hair was removed from an area of about 25 $cm^2$ by means of scissors and a razor. This area was then sprayed with Freon 12 (General Electric, Johannesburg), a refrigerant, for about five to ten seconds, until it was frozen hard.

A method of marking that was first used in 1978 was to insert small numbered fish tags into the ear by means of a special device which punched the hole and inserted the tags at the same time. Genets had been marked by staff of the Park about two years previously and recapture of these genets in otter traps showed the tags still to be in place without any damage to the ear or tag.

To be able to recognise the tracks of individuals a different toe of each of two otters was burnt at the front by means of a hot iron. This was only done in September and October 1977.

Fig. 40 Plastic marker used originally, and an area behind the ear being shaven for freeze-branding.

## RESULTS AND DISCUSSION

At least nine otters were captured a total of 19 times. One otter escaped on 17 March 1977, before it could be examined. This individual, apparently very large, may have been captured again, i.e., it may have been one of the nine otters, or it may have been a tenth individual.

Details on immobilization are to be found in Table 18, while the measurements of otters captured are listed in Table 19.

Dosage rates of Ketalar varied between 6,8 and 16,8 mg/kg, but this apparently caused relatively little variation in the reaction of otters. Otters always recovered from the effects of Ketalar and ACP (acetopromazine) within six hours, although the exact time of recovery was often difficult to determine. As mentioned previously, after immobilization otters were left to sleep in the trap. The trap was only periodically inspected and the otter then released after six to eight hours. Full recovery was taken as the time after which an otter was capable of normal movement and aggression, although the eyes were usually still somewhat swollen at this stage. An otter was never specifically woken up to test its reactions.

The sensitivity to Sernylan was clearly apparent in the two otters on which this drug was used. In the first case a heavy overdose was accidentally administered. Despite this no adverse after-effects were noted following complete recovery. Although the effects of the drug are long-lasting, it probably still has a wide safety margin for otters. In the second case Sernylan was specifically used to keep the otter immobilized a long time, as a radio-transmitter was implanted under the skin.

On the whole *Aonyx capensis* appears to be more sensitive to Ketamine Hydrochloride than other mustelids and viverrids. Average dosage rates required to immobilize skunks and minks varied from 21,6 mg/kg to 107,7 mg/kg (Ramsden *et al.* 1976). Dosage rates for civets (*Viverra civetta*) ranged between 23,2 and 41,4 mg/kg, while that for genets (*Genetta genetta*) varied between 15,0 and 35,3 mg/kg. (Randall 1976). Sensitivity to Sernylan appears to be much the same as that of

TABLE 18

Reaction of otters to immobilization.

| No. of otter | Sex | Weight (kg) | Date | Area | Drug | Initial dosage (mg/kg) | Drug Booster (mg/kg) | Time after initial (min) | Total dosage (mg/kg) | Aceto-promazine dosage (mg/kg) | Ataxia (min) | Full recovery (hrs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 2,7 | | 6– |
| 1 | female | 13,0 | 77–03–02 | gully | Not available | 7,7 | | | 7,7 | 0,6 | 4 | 3 |
| 1 | female | 13,0 | 77–04–29 | gully | Ketalar | 3,9 | 3,8 | 30 | 7,7 | 0,7 | 5 | |
| 1 | female | 12,9 | 77–05–13 | holt 1 | Ketalar | 3,0 | | | 3,0 | | 3 | 27 |
| 2 | male | 10,0 | 77–03–08 | gully | Sernylan | 9,6 | | | 9,6 | 0,4 | 4 | 6– |
| 3 | male | 12,5 | 77–03–23 | gully | Ketalar | 7,3 | 1,2 | 35 | 8,5 | 0,6 | 4 | 6– |
| 4 | male | 16,4 | 77–03–25 | gully | Ketalar | 9,1 | 4,5 | 30 | 13,6 | 0,7 | 5 | 6– |
| 5 | male | 11,0 | 77–04–27 | gully | Ketalar | 5,6 | 4,1 | 27 | 9,7 | 0,4 | 2 | 2 |
| 5 | male | 10,8 | 77–05–03 | gully | Ketalar | 7,9 | 9,4 | 32 | 17,3 | 1,3 | 3 | 3–4 |
| 5 | male | 10,1 | 77–06–29 | gully | Ketalar | 10,2 | | | 10,2 | 0,5 | 10* | 3 |
| 5 | male | 10,8 | 77–07–26 | holt 3 | Ketalar | 8,8 | 4,4 | 27 | 13,2 | 0,8 | 4,5 | 3 |
| 5 | male | 11,4 | 77–09–01 | holt 3 | Ketalar | 16,8 | | | 16,8 | | 3 | |
| 5 | male | 12,5 | 78–03–10 | gully | Ketalar | 6,8 | | | 6,8 | 0,3 | 4 | 4 |
| 6 | female | 11,8 | 77–05–21 | gully | Ketalar | 10,6 | 4,4 | 45 | 15,0 | 1,1 | 5 | 4–5 |
| 6 | female | 11,3 | 77–06–24 | holt 1 | Ketalar | 12,5 | | | 12,5 | 0,8 | 4 | 4–5 |
| 6 | female | 12,0 | 78–01–20 | gully | Ketalar | 0,7 | 0,7 | 180 | 1,4 | 0,7 | | 12– |
| 7 | male | 13,6 | 77–10–06 | holt 1 | Sernylan | 8,1 | 6,1 | 50 | 14,2 | 0,7 | | 3–4 |
| 8 | male | 16,4 | 77–10–27 | holt 9 | Ketalar | 8,4 | | | 8,4 | 1,9 | 3 | 2–3 |
| 9 | male | 11,8 | 77–10–27 | holt 9 | Ketalar | | | | | | | |

* Injection probably subcutaneous

TABLE 19

Measurements of otters captured.

| No. of otter | Sex | TL (mm) | Tail (mm) | Hindfoot (mm) | Ear (mm) | Weight (kg) |
|---|---|---|---|---|---|---|
| 1 | female | 1285 | 495 | 157 | 33 | 13,0 |
| 2 | male | 1130 | 480 | 150 | 30 | 10,0 |
| 3 | male | 1200 | 480 | 155 | 30 | 12,5 |
| 4 | male | 1280 | 520 | 160 | 32 | 16,4 |
| 5 | male | 1170 | 475 | 155 | 30 | 11,1 |
| 6 | female | 1140 | 480 | 145 | 31 | 11,7 |
| 7 | male | 1260 | 530 | 152 | 33 | 13,6 |
| 8 | male | 1270 | 570 | 170 | 36 | 16,4 |
| 9 | male | 1200 | 530 | 151 | 31 | 11,8 |

TABLE 20

Trapping success in different areas. Holt numbers refer to Figure 41.

| Area | Type of trap | No. of nights set | No. of captures | % success |
|---|---|---|---|---|
| gully | S | 140 | 11 | 7,9 |
| holt 1 | S | 30 | 4 | 13,3 |
| holt 2 | S | 10 | 0 | 0 |
| holt 3 | S | 25 | 2 | 8,0 |
| holt 5 | A | 10 | 0 | 0 |
| holt 7 | A | 10 | 0 | 0 |
| holt 8 | A | 13 | 0 | 0 |
| holt 9 | A | 14 | 1 | 7,1 |
| holt 10 | A | 3 | 0 | 0 |
| Total 1 | S | 205 | 17 | 8,3 |
| Total 2 | A | 50 | 1 | 2,0 |
| Total | S + A | 255 | 18 | 7,1 |

S = Standard Caracal trap

A = Aluminium trap

a large range of other carnivores, for which the recommended dosage rate is about 1 mg/kg (Seal _et al_. 1971).

Marking of otters proved unsuccessful to a large extent.

The plastic markers attached to the ears in the early stages of the study were all apparently torn off in the bush. Sadie* (_pers. comm._) mentioned that the same kind of marker used on banded mongooses was actually seen to be torn off when these animals moved through dense patches of bush. The entrances to the lairs of otters were often relatively narrow, and it is suspected that the markers may have been torn off as they moved through these. When otters were recaptured, it was noted that the markers actually tore right through the cartilage of the ear, although this healed completely afterwards.

The fish tags used later, were inserted in such a way that they could not be torn out; the main part of the tag was behind the ear. As mentioned previously, these tags worked very well in genets. No recaptures were made after these tags had been used on otters, and the success of the method could therefore not be determined. One disadvantage of this tag was that it was difficult to see from a distance, while the original plastic markers were fairly easy to see at a distance.

Freeze-branding also proved unsuccessful. It was found that the fine underfur turned completely white after the skin had been frozen, but the new guard hairs remained brown. The marked area could easily be located by looking at the underfur, but it was not visible from the outside.

Marking of otters proved successful enough when identifying otters following recapture, also by means of the metal ear tags, but for identification in the wild, the initial aim of marking, it was not successful.

Comments on ectoparasites are to be found in Appendix 2.

Trapping success varied between different areas where traps were set, but also between the two kinds of traps used (Table 20).

*Mr D Sadie, Department of Zoology, University of the North.

Trapping success in the gully at Goudgate (7,9%) is a good estimate of overall success with the standard trap (8,3%). The relatively high success at holt 1 (Figure 41) can probably be attributed to a large amount of activity at that holt during the specific period that a trap was set there. Similarly the zero capture rate at holt 2 could have been the result of little activity there, as this holt in general was used less frequently than other holts (see next chapter).

Of the 50 times that the aluminium traps were set, only once was a capture made. In this specific case two male otters were caught simultaneously. On the previous night at holt 9 (Figure 41) however, an otter had also been trapped, but it managed to escape by opening the door. This was before a device had been attached to prevent this (Figure 39). The trapping ability of these traps was apparently much lower than that of the heavy standard traps. Concealing these traps with grass made no difference, as otters simply removed the grass.

Average trapping success of 7,1% is regarded as satisfactory, especially when compared with the 1,3% success of Northcott and Slade (1976) after specifically treating their traps with sea water to remove all scent. No other reports of trapping success could be found.

An attempt was apparently always first made to get at the bait from the outside before an otter would enter the trap. At first they were successful, especially with the aluminium traps, but later care was taken to make the bait completely inaccessible from the outside. However, on a few occassions the otters managed to take bait off the treadle from the inside without activating it.

The only bait that proved effective was fish - the larger the better - but two otters were caught without the use of bait. The first night of trapping was such an instance when the first otter was caught. The second time was at holt 1 when the trap had been set by tourists. This was the first night after trapping had been terminated because otters had showed no interest in the bait!

The incidence at holt 9 when two male otters were caught simultaneously is difficult to explain. The otters showed no aggression towards one another, despite evidence suggesting that males may generally be intolerant of one another. A possible explanation may be that the larger otter (16,4 kg) was the sire of the smaller one (11,8 kg), and that males in a family group tolerate one another.

Genets (Genetta tigrina) often proved a nuisance during trapping. They frequently entered the traps to take the bait. In some cases they took it without activating the treadle. At other times they were caught. On a number of occassions small genets were able to squeeze through the mesh of the standard traps after having been caught. Tracks in and around traps proved the culprits to be small genets. Captured genets were also marked with fish tags.

Seagulls were twice caught in aluminium traps. In both cases they were bleeding badly from wounds inflicted while trying to escape. On one occassion a fish eagle was seen trying to remove the bait from an aluminium trap.

Of the nine individual otters caught, three were caught more than once; two females (nos. 1 and 6), and a male (no. 5) (Table 21). They could have been "trap addicts", especially no. 5, but the re-captures over a long period of time still suggest that these three otters were resident within the main study area. Data from tracking and sight records confirmed this, at least for nos. 5 and 6 (see next chapter).

All the individuals that were caught once, were males. It is suggested that these were all males from other areas along the coast which were just passing through the study area. Aonyx capensis does traverse long distances (Maxwell 1960, Tayler 1970), which supports this theory.

TABLE 21

Details of capture and recapture of otters. Holt numbers refer to Fig. 41.

| Otter no. | Sex | Date | Location | Trap |
|---|---|---|---|---|
| 1 | female | 77-03-02 | gully* | C |
| | | 77-04-29 | gully | C |
| | | 77-05-13 | Holt 1 | C |
| 2 | male | 77-03-08 | Holt 1 | C |
| 3 | male | 77-03-23 | gully | C |
| 4 | male | 77-03-25 | gully | C |
| 5 | male | 77-04-27 | gully | C |
| | | 77-05-03 | gully | C |
| | | 77-06-29 | gully | C |
| | | 77-06-26 | Holt 3 | C |
| | | 77-09-01 | Holt 3 | C |
| | | 78-03-10 | gully | C |
| 6 | female | 77-05-21 | gully | C |
| | | 77-06-24 | Holt 1 | C |
| | | 78-01-20 | gully | C |
| 7 | male | 77-10-06 | Holt 1 | C |
| 8 | male | 77-20-27 | Holt 9 | A |
| 9 | male | 77-10-27 | Holt 9 | A |
| ? | male | 77-03-17 | Holt 1 | C |

* Sandy gully at Goudgate (Fig. 41)

C Standard caracal trap

A Aluminium light-weight trap

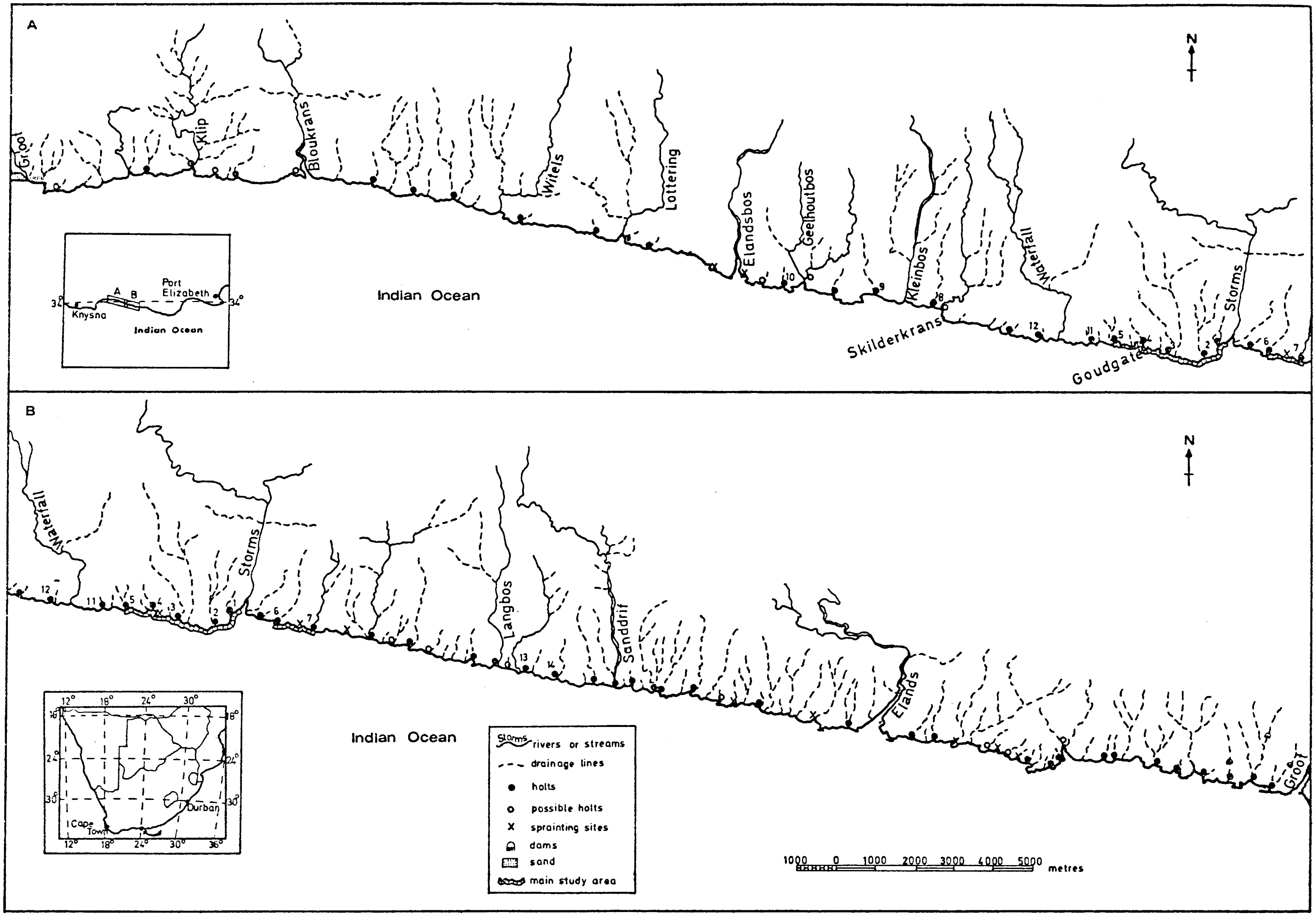



Fig. 41 Distribution of otter holts along the coast of the Tsitsikama coastal National Park. Freshwater was usually present, either as small streams or as pools, at the bottom of drainage lines.

# HOLTS, MOVEMENT AND AN ESTIMATE OF DENSITY

## INTRODUCTION

The most important information needed to determine the status of any animal, is probably the size of the population. The study of many aspects of the biology, such as impact on prey populations and territorial behaviour, is also dependent on this information.

A few estimates of the density of European otters _Lutra lutra_ are available (Erlinge 1967, 1972, Macdonald _et al_. 1978), but apart from an estimate by Tayler (1970), nobody has apparently tried to estimate the density of otters in Africa.

Numerous computational methods of estimating population density have been developed, but most of them, at least for small mammals, are based on capture-recapture data (Delany 1974). Because of the difficult terrain, distribution of otters along the coast, difficulty of trapping and other factors, none of these methods could be applied to the otters at Tsitsikama.

As some form of estimate of density was regarded as essential, it was decided to arrive at an estimation indirectly, by studying the activity of otters at holts and then counting the holts along the coast. By combining these data, and also other applicable data, an estimate of density was produced.

## MATERIALS AND METHODS

A stretch of coast about 3 km in length was studied intensively from January 1977 to January 1978. The eastern boundary of this study area was the open air museum, about 400 m south-west of the Storms River Mouth (Figure 41), while the western boundary was a stream about 900 m from the start of the Otter Trail. This area was easily accessible, most of it being within the tourist area, and included five otter holts.

Holts were visited daily or nearly so, except for a few periods of absence or when other programs demanded attention. During these visits the presence or absence of spraints, tracks, signs of rolling, etc., were recorded, while all spraints were collected. To aid in the location of tracks, sand was regularly spread on well-used otter paths.

Holts 1, 3 and 4 (Figure 41) were visited from January 1977, holt 2 from March 1977 and holt 5 from July 1977.

Another two holts, 6 and 7 (Figure 41), were visited monthly to collect spraints.

After the holts in the main study area had been studied for some time, the whole coast from Nature's Valley to the Groot River at Oubosstrand was searched thoroughly for otter signs. By this time the characteristics of a holt were more or less known and with these characteristics as criteria holts were identified along the complete coast of the National Park.

A book was placed in the last hut on the "Otter Trail" in which hikers were requested to enter sight records of otters. Other sight records were obtained from the diaries of game rangers. At the commencement of this study forms were compiled which regular tourists were requested to fill in when they saw otters. So many reports of otters eating grass or running across the road were received however, that this was discontinued.

On a total of 70 nights fish were placed at various holts and in the sandy gully at Goudgate, regularly traversed by otters. These fish had been marked by inserting coloured beads into the mouth; a specific colour for each holt. When these beads were recovered in spraints, movement patterns could be established.

A radio transmitter donated by Professor T Erasmus of the University of Port Elizabeth was on one occassion implanted under the skin on of an otter. The transmitting signal was fairly strong, with reception still favourable at 100 m. As soon as the otter entered the water however, the signal became inaudible and the otter could not be tracked again. The otter may have moved far off, or the transmitter may have failed.

Recognition of individual tracks proved virtually impossible. To aid in recognition, a toe of a hindfoot of two otters was burnt at the front to shorten the toe and therefore change the spoor. The fourth toe of the right hindfoot of a male otter (no. 5) and the third toe of the left hindfoot of a female otter (no. 6) were burnt. This was only done in September and October 1977. Both these otters were caught again at a later stage, and the wounds had healed perfectly. Tracks also indicated that the wounds did not hamper movements.

During the first part of the study period the width of tracks in sand was measured with the aim of identifying individuals from tracks. Tayler (1970) had reported this method to be very reliable. In this study however, the method proved unsuccessful. Only in January 1978 was a different kind of measurement, i.e. distance between tracks, taken.

The order in which the feet of an otter are placed on the ground, is always as follows : (1) Right hind foot (rhf), (2) Left fore foot (lff), (3) left hind foot (lhf), (4) right front foot (rff). The distances measured were rhf-lff, lff-lhf, lhf-rff, rff-rhf, in that order. These four measurements were then expressed as a ratio.

# RESULTS

## HOLTS AND THEIR UTILISATION

The five individual holts in the main study area varied, but some features were characteristic of every holt. The two most important ones were probably the presence of shelter in the form of bush or forest, and the presence of fresh water.

All five holts, when first discovered, had about 20 to 50 spraints, from very old to fresh, lying around, mostly confined to specific areas.

Paths were present in all holts, in some more visible than others. Visibility depended to a large extent on the structure of the vegetation. In long grass, reeds or short shrubs the paths were well-defined, but under higher bush, and also on very short grass, they were sometimes difficult to distinguish. Where they entered fresh water they were usually clearly visible.

Several sleeping sites were present in each holt, interconnected by paths. These sites were open areas, always under thick bush. They were clearly visible in all holts except holt 2, but extensive searching was sometimes needed to discover them. Not all sleeping sites were found, as many were probably in bush too dense to enter.

The habit of rolling on vegetation or sand when leaving the water was observed a few times. The sites on which this rolling took place were specific and usually clearly visible. Sand appeared to be a favoured substrate, as the areas where sand was spread to record tracks were often used as rolling sites.

Holt 1 was situated around the mouth of a very small stream entering the sea immediately north of Mooibaai, in the vicinity of the open air museum, but not on the western side. This stream occassionally dried up, but it contained water most of the time. Slightly north-east of this stream was a marshy area, still within the area of the holt, which was never seen to dry up completely. Fresh water was therefore always available, although sometimes in small quantities and of poor quality. The exact area of the holt was impossible to estimate, but was probably of the order of about 3 000 $m^2$. Two entrances were known. One was directly into the mouth of the stream, in which case an otter would immediately enter the forest from the sea. The other was via the rocks and patches of grass into an opening in a thick patch of bush which went over into forest. There were several areas along this route where otters could enter the forest, which they occasionally did.

Rolling sites varied, but two commonly used sites were on open areas in the forest beside the stream and the patches of grass on the edge of the bush. These were also the main sprainting sites.

Holt 2 was a relatively small patch of bush in front of cottages 7 to 10. The extent of the actual holt could not be determined, and few signs of activity were found within the bush. Two main sprainting and rolling sites on a large patch of grass were known. That this area was a holt was proved by the fact that otters were seen entering or leaving the bush on several occasions. Fresh water was limited to a few pools formed from seeping water, which did not dry up completely during the study period.

Holt 3 was a patch of bush around a stream immediately west of the main camping area. Inside this patch of bush were two further camping sites. Just before this stream entered the sea, there was a large fresh water pool on the western side of it. Beside this pool and more towards the sea, were several patches of grass which were utilised as rolling- and sprainting sites. Rocks were also used as sprainting sites. The sleeping sites were all situated in rather short, dense bush, especially the steep, dense area of bush bordering the rocks east of the stream.

Holt 4 was situated around the mouth of a stream entering the sea just west of the bay reserved for snorkel-diving for tourists at Goudgate. The bush here was unlimited and from paths, etc. it appeared that this holt covered a far greater area than the previous two holts. It was probably about the same size as Holt 1, or perhaps larger. The last part of the stream flowed down a rather steep face of grass and then rocks. The grass patches were used for rolling and the main sprainting sites were in this area too. Once again however, as in previous holts, spraints were found throughout the bush. The few sleeping sites that were found, were all in the dense, stunted bush bordering the rocks.

Holt 5 was about 700 m west of the previous holt, again around the mouth of a permanent stream on the western side of Toorbaai. Surface area of this holt was estimated at at least about 10 000 $m^2$. This holt had at least three entrances, two near each other, but the third about 70 m away. The third one appeared to be used far less frequently than the other two. Rolling and sprainting sites were again on grassy patches around the two main entrances, although other sprainting sites were present on the rocks nearer the sea.

Holts 6 and 7 were similar to the previous ones in that they were situated at the mouths of streams. The stream of Holt 7 appeared permanent, but the one of Holt 6 dried up from February to April 1977. It was notable that few spraints were collected during this dry period; activity at the holt had definitely diminished. Holt 6 was situated about 20 or more metres above sea level, and otters had to climb a long way to get to the main part of the holt. Rolling sites in this case were also high up on patches of grass along a fresh water pool. Sprainting sites were mainly lower down on the rocks.

The stream of Holt 7 flowed through a few large pools between grass and rocks before it entered the sea, and this was again the area of most rolling and sprainting activity.

In all seven holts, and others studied, more than one sprainting site was present. By studying the seven holts over a long period of time, a particular pattern of utilisation of these sprainting sites became apparent. A particular site was used for a few days and in exceptional cases up to a few weeks in succession. After this the site was abandoned and another site was used, again for a varying period of time. Occasionally a site was used only once. After a while an old site would again be used for a length of time. The period for which a site was used varied considerably, while there appeared to be no pattern of rotation. The same pattern of defaecation was practiced by a tame otter.

Sprainting sites were usually associated with entrance routes, and the alternation of sprainting sites was correlated with alternation of entrance routes. This may perhaps be an anti-predator strategy. One permanent fixed route would make predation fairly easy. The only potential predator in Tsitsikama however, is probably man.

Results of the regular determination of otter activity at holts in the main study area, are summarised in Tables 22 and 23. Visits to the holts during February, March and April 1978 were infrequent, while a severe storm in May 1977 made recognition of signs of activity impossible for a period of seven days. These results were therefore not included. In July, September, October and November 1977 the holts were visited only during parts of the month for the reasons already mentioned. In Table 24 the different kinds of signs from which activity was deduced are summarised.

The most obvious feature of these data is perhaps their variation. In the case of one holt (Holt 4) for example, monthly percentage utilisation appeared to vary between 7,1% and 54,6%, although sample size for both these estimates was rather small. Similar variation occurred in other holts. Average percentage utilisation varied from 21% at holt 2 to 44% at Holt 5.

The results of Holts 3 and 4 were probably the most reliable. The similarity of the proportions of different signs at these two holts was striking (Table 24). In both these holts there was one main entrance along a fresh water stream with about four sprainting sites associated with it. In the 12 and 13% of cases where spraints only were recorded (Table 24), the otters probably moved over the rocks just beside the main entrance, or through the fresh water stream, where tracks could not be recorded.

Holt 5 had a higher proportion of spraints only (Table 24), indicating that there were more routes of entrance than the two which were covered with sand. The one entrance area was a large open area of pebbles and short grass, and otters could easily move past the patches of sand. This holt was also spread out much more than Holts 3 and 4, and signs indicated several entrances which were only occasionally used. The proportion of tracks only (22%) was about the same as at Holts 3 and 4. This holt as a whole therefore appeared to be used more than the

TABLE 22

Utilization of holts January 1977 to January 1978.

| Month | HOLT 1 | | | HOLT 2 | | | HOLT 3 | | | HOLT 4 | | | HOLT 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | signs* | visits+ | %i | signs | visits | % | signs | visits | % | signs | visits | % | signs | visits | % |
| January | 11 | 26 | 42,3 | | | | 3 | 8 | 37,5 | 6 | 11 | 54,6 | | | |
| February | 13 | 28 | 46,4 | | | | 10 | 28 | 35,7 | 7 | 28 | 25 | | | |
| March | 11 | 31 | 35,5 | 10 | 31 | 32,2 | 10 | 31 | 32,3 | 7 | 31 | 22,6 | | | |
| April | 4 | 30 | 13,3 | 1 | 30 | 3,3 | 10 | 30 | 33,3 | 8 | 31 | 25,8 | | | |
| May | 18 | 24 | 75,0 | 9 | 31 | 29 | 6 | 24 | 25 | 6 | 24 | 25 | | | |
| June | 17 | 29 | 58,6 | 4 | 29 | 13,8 | 9 | 29 | 31 | 13 | 29 | 44,8 | | | |
| July | 4 | 12 | 33,3 | 4 | 12 | 33,3 | 7 | 12 | 58,3 | 3 | 12 | 25 | 4 | 12 | 33,3 |
| August | 13 | 31 | 41,9 | 9 | 31 | 29 | 12 | 31 | 38,7 | 6 | 31 | 19,4 | 17 | 31 | 54,8 |
| September | 4 | 10 | 40 | 1 | 10 | 10 | 4 | 10 | 40 | 4 | 10 | 40 | 5 | 10 | 50 |
| October | 1 | 12 | 8,3 | 3 | 12 | 25 | 5 | 12 | 41,7 | 5 | 12 | 41,7 | 4 | 12 | 33,3 |
| November | 1 | 14 | 7,1 | 3 | 14 | 21,4 | 3 | 14 | 21,4 | 1 | 14 | 7,1 | 6 | 14 | 42,9 |
| December | 12 | 25 | 48 | 9 | 25 | 36 | 8 | 25 | 32 | 6 | 25 | 24 | 11 | 25 | 44 |
| January | 10 | 31 | 32,3 | 1 | 31 | 3,2 | 11 | 31 | 35,5 | 7 | 31 | 22,6 | 12 | 31 | 38,7 |
| TOTAL | 119 | 303 | 39,3 | 54 | 256 | 21,1 | 98 | 285 | 34,4 | 79 | 289 | 27,3 | 59 | 135 | 43,7 |

* Number of days that signs of activity were present.

\+ Number of days that holt was visited.

i % of days that otters apparently visited the holt.

TABLE 23

Average monthly utilisation per holt, January 1977 to January 1978. Holt numbers refer to Figure 41.

| Month | Total days signs present | Total visits | Average utilisation (%) | Holts considered |
|---|---|---|---|---|
| January | 20 | 45 | 44,4 | 1,3,4 |
| February | 30 | 84 | 35,7 | 1,3,4 |
| March | 38 | 124 | 30,7 | 1,2,3,4 |
| April | 23 | 121 | 19,0 | 1,2,3,4 |
| May | 39 | 103 | 37,9 | 1,2,3,4 |
| June | 43 | 116 | 37,1 | 1,2,3,4 |
| July | 22 | 60 | 36,7 | 1,2,3,4,5 |
| August | 57 | 155 | 36,8 | 1,2,3,4,5 |
| September | 18 | 50 | 36,0 | 1,2,3,4,5 |
| October | 18 | 60 | 30,0 | 1,2,3,4,5 |
| November | 14 | 70 | 20,0 | 1,2,3,4,5 |
| December | 46 | 125 | 36,8 | 1,2,3,4,5 |
| January | 41 | 155 | 26,5 | 1,2,3,4,5 |
| TOTAL | 409 | 1268 | 32,3 | |

TABLE 24

Occurrence of different kinds of otter signs at five holts after visits by otters. March 1977 to January 1978. Holt numbers refer to Figure 41.

| Holt | Tracks* only | | Spraints only | | Tracks and Spraints | | n |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | |
| 1 | 51 | 54,8 | 12 | 12,9 | 30 | 32,3 | 93 |
| 2 | 24 | 44,4 | 7 | 13,0 | 23 | 42,6 | 54 |
| 3 | 20 | 23,5 | 11 | 12,9 | 54 | 63,5 | 85 |
| 4 | 14 | 21,2 | 8 | 12,1 | 44 | 66,7 | 66 |
| 5 | 13 | 22 | 16 | 27,1 | 30 | 50,8 | 59 |
| Total | 122 | 34,2 | 54 | 15,1 | 181 | 60,7 | 357 |

* Any sign other than spraints

previous two holts, but more data might have proven this conclusion wrong. A typical pattern of utilisation of a particular holt was often a visit on one or a few successive nights and then no visits for a time. If only visits during a part of a month are recorded, such a pattern, or lack of pattern, might influence the results significantly.

Holt 2 appeared to be different from the rest. Utilisation was estimated at about 21% (Table 22), which was far less than that of other holts. Furthermore 44% of all activity records were of tracks only (Table 24). The possibility that another sprainting site existed in the bush cannot be excluded, but this is regarded as unlikely. This holt was probably frequently used only to obtain fresh water. On several occasions otters were seen to enter or leave the bush however, so that it must have been a holt. The fact that relatively little shelter was available, or the close proximity to tourist residences, may have been the reason for the lesser importance of this holt.

As another consideration, this holt may perhaps be compared with the subsidiary holts mentioned by Kruuk and Hewson (1978). These were holts of Lutra lutra on the Scottish coast used to a lesser extent than the main holts. The function of these holts could not be explained by them.

As is mentioned later, several areas along the coast were found about which doubt existed as to whether they were actually holts or not (Figure 41), mainly because of the fact that activity in these areas appeared to be less than at other clearly recognisable holts. Utilisation of these holts may have been similar to that of Holt 2 in the main study area, although an explanation is then not apparent.

The data for Holt 1 are somewhat difficult to interpret. Otter signs were mainly encountered on two sites, one beside the stream inside the forest and one on a patch of sand and short grass at the edge of the forest. About 85% of all records from the open area consisted only of tracks or signs of rolling (mainly on the sand which was placed on a patch to record tracks). Frequently these tracks did not coincide with any signs inside the forest, or at least no signs could be found. It would therefore appear that a normal travelling route may have passed through this area. Numerous tracks and spraints recorded all along the coast, suggested that otters spend a lot of time travelling on land, as appears to be the case inland (Shortridge 1934, Dorst and Dandelot 1970). The observations at this holt would seem to fit this theory. All records can not be explained by this, however, as paths and actual observations indicated that this area was also used as an entrance to the holt.

If the data for the forest area alone were to be taken into account, percentage utilisation would work out at 24% in contrast to the 39% of the two areas combined (Table 22). Spraints and also tracks however, were often difficult to find in the forest. A strong smell often suggested that spraints were present, although they could not be found. The value of this may be appreciated from the fact that in three cases following up of the scent led to the discovery of a sleeping otter, with a few spraints at the actual sleeping site. This practice was soon discontinued for fear of disturbing the otters. The estimate of 24% is therefore likely to be conservative.

As it was impossible to determine whether an otter was just passing by or whether it actually entered the holt, the estimate of the forest- and open areas combined was retained as estimate of percentage utilisation of Holt 1. This would make a difference of 4% to the total estimate of the five holts combined. The degree of accuracy of this method is low however, and this difference would be of little importance. Furthermore, the total estimate of utilisation is probably too low, as otters probably visit holts occassionally without leaving any signs. In that case the 4% would act as a kind of correction factor.

When the results of Holts 1 to 5 were combined, average utilisation per holt worked out at 32,3% (Table 23). Average montnly utilisation varied from 19 to 44% per holt; about the same range of variation as between individual holts. To put these results in other words : a holt was apparently visited by an otter on average about once in every three days.

If this result meant that for every three holts there was one otter, population size could simply be calculated by dividing the number of holts by three. Before this could be done however, several assumptions would have to be taken into account.

The first assumption would be that signs were always present when an otter had visited a holt. To prove this was very difficult, but some evidence is available to indicate that this was usually the case.

Table 25 indicates the extremely good correlation that existed between sight records of otters at holts and the presence of signs, mostly spraints. Only sight records of otters in a holt, or entering or leaving it, or directly in front of it, were taken into account, and 24 out of the 28 were recorded by myself.

Five cases of absence of signs after an otter had been seen were recorded, four of them at Holt 1. One of these sight records was made by a person accompanying Dr Robinson in a boat who saw an otter swimming in Mooibaai. Dr Robinson himself however, did not see it. This record could therefore not be confirmed. The other three sight records were made by myself and Dr Robinson. The difficulty of recording signs in Holt 1 has been mentioned, and this may have been responsible for the fact that signs could not be found.

The fifth case of no correlation was at Holt 5 on 17 August 1977. In this case an otter was seen swimming past Holt 4 towards Holt 5. Sight was lost of this otter in front of Holt 5, and it was assumed to have entered the holt. In that case it did not enter through one of the main routes. A possible reason may have been that it had seen me and therefore entered the holt as unobtrusively as possible. The possibility that it had moved past the holt however, could not be excluded.

It may be of interest that in 3, or 13% of the 23 cases of positive correlation, only tracks were present, while in the other cases spraints, or spraints together with tracks were present. Taking into account that sand was only thrown on paths from February onwards, this compares favourably with the 21 to 24% of cases where only tracks could be found in Holts 3 to 5 (Table 24). It would appear then that the presence of spraints explained about 80% of all utilisation in an "average holt" if the spraints could be easily found.

It may be assumed that signs are usually, but not always present when an otter visits a holt. This could be responsible for a slight underestimate of utilisation from signs.

TABLE 25

Correlation between sight records of otters at holts and the presence of sign.

| DATE | HOLT | OBSERVER | SIGN |
|---|---|---|---|
| 7/1/77 | 1 | a | x |
| 11/1/77 | 1 | a | s,t |
| 13/1/77 | 1 | a | s |
| 17/1/77 | 1 | a | s |
| 18/1/77 | 1 | a | s |
| 20/1/77 | 1 | a | s |
| 21/1/77 | 4 | a | s |
| 22/1/77 | 4 | a | s |
| 31/1/77 | 6 | g | s |
| 11/2/77 | 1 | t | x |
| 17/2/77 | 1 | a | s,t |
| 22/2/77 | 3 | a | s,t |
| 3/3/77 | 3 | a | s,t |
| 6/3/77 | 2 | t | s |
| 14/3/77 | 2 | a | s |
| 15/3/77 | 9 | a | s |
| 17/3/77 | 1 | a | t |
| 12/3/77 | 1 | r | x |
| 11/4/77 | 4 | a | s,t |
| 18/4/77 | 3 | a | s,t |
| 21/4/77 | 4 | a | s,t |
| 13/6/77 | 1 | a | x |
| 26/7/77 | 2 | a | s,t |
| 17/8/77 | 5 | a | x |
| 30/8/77 | 5 | a | s,t |
| 10/11/77 | 5 | a | t |
| 14/2/78 | 4 | a | t |
| 15/2/78 | 5 | a | s |

g = game ranger
a = author
r = Dr Robinson
t = tourist
s = spraints
t = tracks, signs of rolling, etc.
x = no sign

A second assumption is that the presence of signs always correlates with the presence of an otter in the holt. This was still more difficult to prove. In a few cases following up signs led to the finding of an otter. Apart from being extremely time consuming and difficult however, this method would most probably lead to serious disturbance of the otters. It could therefore not be used regularly.

If an otter always left signs when it entered or left a holt, each stay-over would be recorded as two sets of signs; one when the otter entered the holt and the other when it left the holt the following night. Figure 42 indicates that this is often not the case. The frequencies of different numbers of successive days that signs were recorded for each holt were calculated and then totalled. The high percentage of single-day records (61%) (Figure 42) is striking, and contrary to expectation. From previous reasoning a predominance of two successive days of records would be expected.

Two possibilities are apparent. One is that otters mostly leave signs only during one direction of movement; either in or out of the holt. The other possibility is that at least 61% of visits to holts were short visits where the otters did not stay in the holt during the day.

If the second alternative were true, the figure for percentage utilisation of 32% would come down to a maximum of 13% (39% of 32%) for purposes of staying during the day, which would mean that there would be about one otter in every eighth holt. A maximum of 62 holts were found along the whole coast (see next section), and population size would then be about eight otters along the whole Tsitsikama coast. In the main study area alone seven otters were caught, while a further two were caught only about 9 km away. Seven of these nine otters were males.

This alternative is clearly impossible, and the first alternative must therefore be considered.

Most signs were probably made when an otter entered a holt. This was deduced from the fact that spraints were by far the best indicator of activity; about 80% of all signs at three holts included spraints (Table 24). It is known for otters in general (Duplaix-Hall 1975), and was observed on the tame clawless otter of Dr Robinson, that food passes

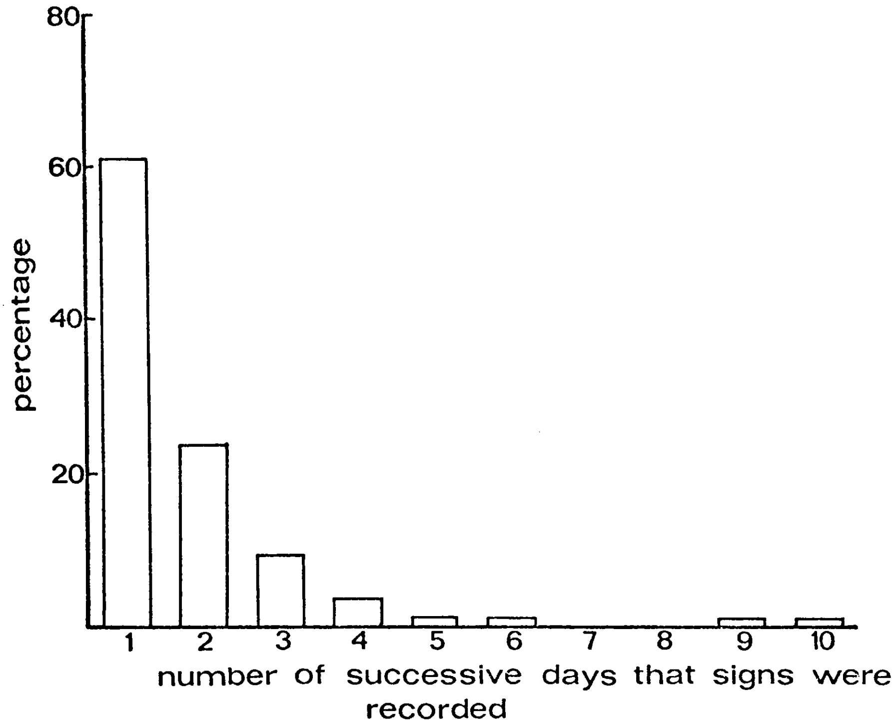



Fig. 42 Frequency distribution of the number of successive days on which signs of otters activity were found at holts. Results of holts one to five combined. n = 400

through the digestive tract in about one to three hours. An otter would therefore soon get rid of any remains of food in the digestive tract after having entered a holt; either at a sprainting site or at its actual sleeping site. By observing otters when leaving holts, it was confirmed that they usually make directly for the sea without sprainting, often through a fresh water stream. On one occasion only, a female with two full-grown cubs (deduced from behaviour) was seen to swim around in a freshwater pool, move onto the rocks to urinate and then swim around in the pool again before entering the sea.

The habit of rolling by otters, is presumably to dry their fur. This would therefore only be done when an otter left the water, in other words when it entered a holt. The typical behaviour associated with entering a holt, as observed three times and deduced from signs several times, was apparently to enter fresh water, climb onto land to roll on grass or sand and then to defaecate.

It may now be assumed that most of the signs made by otters, were made when entering a holt, while signs were seldom left when leaving a holt. Some of the tracks found without any sign of sprainting, could probably be attributed to otters leaving holts, at least in Holts 3 and 5. In many cases however, the direction of tracks was definitely into the holt, or signs of rolling were present.

Henceforth it has been assumed that in most cases the presence of signs indicated that an otter was present in the holt. A possible factor of overestimation may be present in this assumption, because of the fact that some of the signs may have been made during short visits without staying in the holt.

A third assumption is that otters use only holts to spend the daytime. This assumption is bound to be more or less correct, as all otters seen to enter or leave the shore, were only seen to do so at holts.

The otter seen by Dr Robinson in the gully entering the Storms River gorge, may have been an exception, or it may just have been en route. Furthermore this was at night. On one occasion an otter was suspected to be present in the bush beside a marshy area between Holts 4 and 5.

A strong smell of urine was present and a few bushes were flattened. This was the only time during the whole study period that an otter may have slept in this area. It is possible therefore, that otters occasionall slept in areas other than holts, but if it happened, it probably did so so infrequently as to be negligible.

It has now been assumed that an otter normally left signs of activity when entering a holt, that signs normally indicated the presence of an otter in the holt, and that otters normally only slept in holts. For later purposes however, it is also important to know how many otters visit a holt at a time.

The solitary habits of Aonyx capensis along the Tsitsikama coast are immediately apparent from Table 26. Seventy-eight percent of all sight records by the author, tourists and staff of the Park were of single otters. Three of the sight records of two otters and nine of the records of three otters were definitely females with cubs. The one sight record by myself of four otters was a female with two cubs together with another individual, presumably a male. As the cubs apparently stay with their mother until full-grown, some or all of the other sight records of two or more otters may also have been females with cubs. Some of the records of two indistinguishable otters may have been of courting pairs, but seven of the 14 records were in January or February, while the other seven were between March and August. This correlated better with the breeding season than with the mating season. The breeding season appeared to be about from midsummer to the end of summer. With a gestation period of two months (Dorst and Dandelot 1970), the mating season should then be in the beginning of summer, more or less from October to January.

Table 26 includes all sight records of otters at holts, so that it may be assumed that, save for a few exceptions, one otter visits a holt at a time. The main exception is the case of females with cubs, while there was evidence that males occasionally visited females with cubs in holts. An otter (presumably male) was once seen to leave Holt 4 at sunset, and about 15 minutes later a female with two cubs was seen to emerge.

A short aggressive encounter was once witnessed between two otters entering the same holt (3). One otter went into the holt at 19 h 20, rolled and sprainted, while about five minutes later another otter arrived. When this otter climbed into the main holt over a slight rise, it was confronted by the first otter making undefinable aggressive noises. The second otter immediately retreated, rolled around for some time and then went into the sea again. This incident apparently confirmed the solitary habits of Aonyx.

TABLE 26

Group sizes of otters

| Group size | Number of sight records | | | | |
|---|---|---|---|---|---|
| | Author | Game rangers | Tourists | Dr Robinson | Total |
| 1 | 23 | 57 | 29 | 2 | 111 |
| 2 | 4 | 7 | 6 | | 17 |
| 3 | 7 | 2 | 3 | | 12 |
| 4 | 1 | 1 | | | 2 |
| Total | 35 | 67 | 38 | 2 | 142 |

## DISTRIBUTION AND DENSITY OF HOLTS

At least 51 holts were found along the whole coast; 21 west and 30 east of the Storms River Mouth. Another seven areas west and seven east of the Storms River were found with indications of otter activity, but doubt existed as to whether these were actually holts or not (Figure 41).

Some areas were apparently used as regular sprainting sites, but not as holts. About 11 such areas were found along the coast (Figure 41). A sprainting site is difficult to define, as otter spraints were to be found all along the coast. Regular sprainting sites were arbitrarily defined as areas with 10 or more spraints. One such site was the sandy gully at Goudgate, through which otters regularly travelled (Figure 38). Spraints were collected from this area 45 times in 15 months (Table 27).

TABLE 27

Use of the sandy gully at Goudgate as a sprainting site.

| Month | No. of times used |
|---|---|
| January | 4 |
| February | 8 |
| March | 3 |
| April | 8 |
| May | 0 |
| June | 3 |
| July | 0 |
| August | 4 |
| September | 5 |
| October | 2 |
| November | 1 |
| December | 1 |
| January | 5 |
| February | 0 |
| March | 1 |

Certain areas indicated on the map of the coastal area (Figure 41) were probably holts, but doubt existed for various reasons. In some cases spraints were present, but signs of habitation were not clear, although enough shelter was present. In other cases signs of habitation existed, but very little shelter was present or few spraints were to be found. These areas, like Holt 2, have already been compared to the subsidiary holts mentioned by Kruuk and Hewson (1978).

The area indicated nearest to Nature's Valley, had a small fresh water pool, together with about 30 spraints, but shelter in the form of bush was rare. This particular site however, was very difficult to reach by land, and much shelter might therefore not have been required. Seven sight records of one or more otters swimming near this area were recorded by the Ranger stationed at Nature's Valley, while tracks of otters on the sand at Nature's Valley were recorded 29 times. This gave rise to the hypothesis that this area might have been a holt.

Four otters were seen by the same Ranger at the Klip River Mouth. During several visits fresh spraints were found only twice on the rocks at the mouth, while few signs of habitation were found. A lot of shelter was present higher up along the river, in which a holt may have been situated. If this was a holt however, it was not frequently used. The otters seen by the Game Ranger may just have been on their way to other holts.

The mouth area of the Bloukrans River was not thoroughly searched. The fact that otters were reported five times from the mouth of this river by hikers, suggested that a holt may have been situated somewhere near the mouth, as for example in the Lottering River mouth. Here the holt was situated beside a fresh water pool formed by seeping water in a gully entering the river mouth.

At the Elandsbos River Mouth and slightly to the west of it, were two sprainting sites. The one at the mouth was frequently used. Tracks suggested that otters came out of the sea, visited the sprainting site and went back into the sea. No signs of habitation were found at the sprainting site or higher up the river. Between Elandsbos River and the holt just east of Lottering River, 15 sight records were reported, mainly by the Game Ranger stationed at Lottering River Mouth. No shelter was available in this area and all these otters were probably just travelling to and from other holts.

Otters occasionally visited the Geelhoutbos River, went some distance up the river and then back to the sea again. This could be deduced from tracks. There were very few signs of habitation, but also very few spraints. Regular visits to this area, and also the lack of reports from hikers sleeping in the hut right at the mouth, suggested that otters entered the mouth infrequently.

The river just west of Skilderkrans enters the sea between relatively steep and inaccessible rocks, and very little shelter was present. Spraints were found on the rocks however, and two otters were once seen swimming there. Although this area was probably not a holt, it was suspected that otters moved inland via this river mouth to cross the Skilderkrans area on their way to more eastern holts. Tracks and spraints on top of the escarpment at Skilderkrans indicated that otters apparently moved over land here. This was to be expected as the sea was extremely rough and probably very dangerous at this point.

A group of otters were once seen to play in the Waterfall River (± 4,5 km west of Storms River Mouth). About 10 spraints were collected the following morning. Apart from this activity, only occasional single spraints were found in this area. No shelter was available and it was definitely not a holt.

The eastern section of the Park (east of Arrie se baai, about 1,8 km east of Storms River Mouth), was not as extensively studied as the western section. Most parts of it were only visited once. It became immediately apparent however, that the density of holts in this section was higher than that of the western section. This coincides with a higher density of fresh water streams and pools (Figure 41).

The seven areas where doubt existed as to whether they were holts or not were all areas with relatively few signs of habitation. If they were holts, they were very seldom used.

The Elands River Mouth was not searched very well, and a holt may have been present here.

Although no actual figure is available, the density of spraints as a whole was much higher in the eastern section than the western section. Many more single spraints were found all along the coast.

All otters holts found along the coast, except one, were directly associated with fresh water. This varied from fairly large streams such as Langbos River and Sanddrif River to a shallow pool of fresh water with a surface area of about 2 $m^2$ at Stilbaai, about 0,8 km west of the Lottering River (Figure 43).

The one exception was Holt 13, about 800 m east of Langbos River (Figure 41). This holt was situated between two fresh water streams about 300 m apart, and paths were present from the holt to both streams. Directly in front of the two streams the sea appeared very rough, and the larger stream cascaded down a large cliff into the sea. Directly in front of the holt the sea appeared much more negotiable. An otter was actually seen to leave this holt to enter the sea in front of it, but an accidental confrontation persuaded it to go back.

Although this holt was not directly beside a fresh water stream or pool, it was still obviously associated with it. Accessibility was probably more important than the distance from fresh water.

The obvious association between holts and fresh water is in contrast with the finding of Kruuk and Hewson (1978), that holts of Lutra lutra in a coastal environment were never along streams.

Fresh water was not always associated with a holt. With a few exceptions, these were always cases where no shelter was available, for example where the mouth of a stream was a sheer face of rocks.

Straight-line distances between 44 certain holts were calculated, as actual distances were impossible to measure. These varied from 0,3 km to 2,4 km, with an average distance of 1,0 km. 72% of these were between 0,3 and 1,1 km (Figure 44). These results compare favourably with those of Kruuk and Hewson (1978), who found an average straight-line distance between holts of Lutra lutra of 1,16 km.

a

b

Fig. 43 Two examples of holts

a) The holt at Stilbaai, immediately west of Lottering River (Fig. 41). The small pool indicated was the only fresh water present.

b) Holt 7 (Fig. 41). The large pool in the foreground was fed by a perennial stream.

Ample shelter present in both holts.

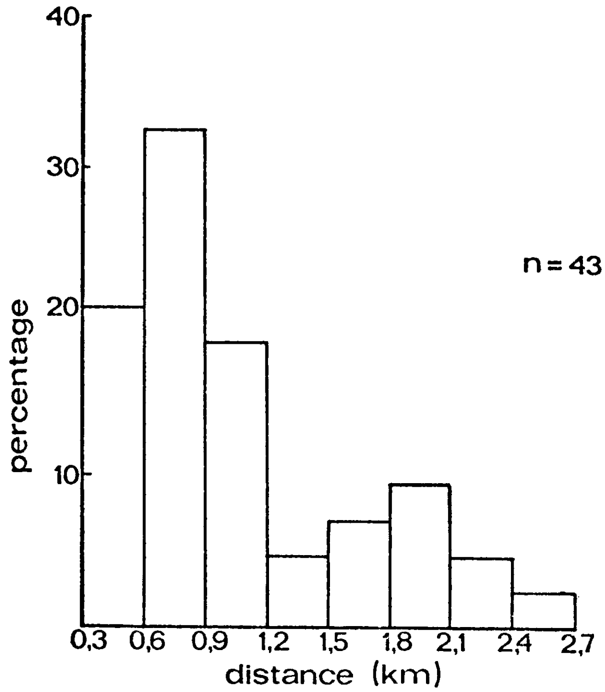



Fig. 44 Frequency distribution of straight-line distances between holts.

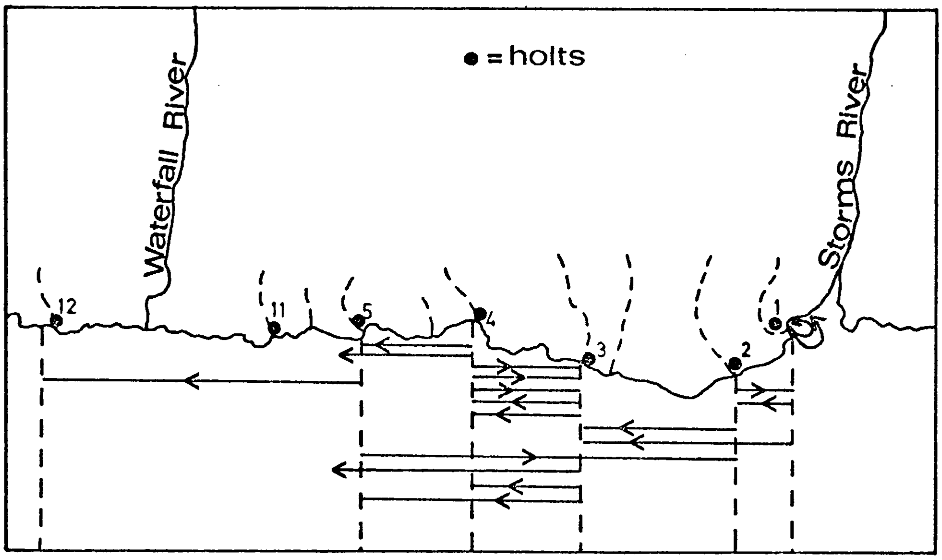



Fig. 45 Some recorded nightly movements of a female otter (no. 6) with cubs between 77-01-22 and 77-03-18, and between 78-01-30 and 78-02-16.

MOVEMENT PATTERNS

Very few data on the movement of otters in general could be obtained, but some of the movements of a few specific otters could be deduced from tracks and sight records.

The marking of otters, as mentioned previously, was unsuccessful in so far that marked otters could only be recognised when retrapped. Field identification proved impossible.

Identification of the tracks of the two otters of which a toe was burnt, proved fairly successful. The track of no. 5 was easier to recognise than that of no. 6, but identification of both was dependent on undisturbed fine, moist sand.

The one exception to identification in the field, was a female (no. 6) which had two cubs in the first five months of 1977 and one from about February 1978. Because these cubs always moved together with their mother, the group was easy to identify in the field as well as from tracks.

From the day that this group was first seen, 21 January 1977, until the last day that signs of the last of the first two cubs were seen, 29 May 1977, 32 locality records of the group were obtained, 12 at Holt 4, eight at Holt 3, five each at Holts 1 and 2, and two at Holt 5. Holt 4 appeared to be the centre of activity.

In some cases actual movement during the night could be deduced from signs (Figure 45). Most of the time they appeared to move short distances; about 0,8 km to 2,5 km.

On the night of 5 May one of the cubs died during very rough weather; apparently from exhaustion. Tracks of the other cub were still seen together with those of the female until 29 May 1977, but never thereafter. As it was not full-grown yet, it may also have died.

At the beginning of 1978 female no. 6 had another cub. Whether there were more originally, is impossible to tell. With this cub she apparently preferred to stay in the western section of her home range, as they were seen only once at Holt 4 (78-02-14), once at Holt 5 (78-02-15), and once swimming past Holt. 1. Tracks were recorded twice at Holt 5, once at Holt 4 and once at Holt 3. On the night that they moved from Holt 4 to Holt 5, they moved through a sandy gully, and their tracks were recorded here. After this their tracks were recorded only twice in this gully. Signs of activity of this group were once seen at Holt 12 (west of the Waterfall River).

This female was trapped four times; twice in the sandy gully at Goudgate and twice at Holt 1. Her tracks were regularly identified in the sandy gully however, and confirmed her residence in the area.

It is obvious that the coastal area from Holt 1 to 5 was only part of the home range of this female; in just more than four months they were recorded within this study area only 32 times. There may have been cases where they could not be identified from their signs, but in general the small tracks and spraints of the cubs made this group easy to recognise.

The boundaries of the home range of female no. 6 could not be determined, but it can be said that the home range was at least, but definitely more than 5 km; from Storms River Mouth to the first holt west of the Waterfall River.

During March 1978, when a large portion of the eastern section of the Park was searched for otter signs, the minimum home range of another female with two cubs could be determined from tracks.

Tracks and spraints of this group were found from Holt 7, about 1,8 km east of Storms River Mouth, to Holt 14 (west of Sanddrif River), a distance of about 6,5 km. This female was different from any other in the main study area, as the ratio of her tracks was on average 0-4-5-1 (see next section). Several measurements, and also the similarity in size of tracks of the cubs indicated that the same group was involved in all sightings of signs. Once again the home range of this female was probably larger than the recorded 6,5 km.

The home ranges of the two females with cubs appeared to be completely separated.

Three sightings of a group of three otters were made between 16 February and 22 March 1977. The two sightings by the author were at Holts 8 and 10 (Figure 41). In both cases it was deduced from behaviour that the group consisted of a female with two cubs, although the cubs were about the same size as the adult female. The other record was from hikers, who saw three otters swimming in the sea at Geelhoutbos River Mouth.

Holts 8 and 10 were about 4 km apart, and the Geelhoutbos River Mouth was between them. It may well be that the abovementioned sight records were all of the same female with cubs. The minimum home range of this group would then be 4 km, which is smaller than the two other minimum home ranges of females with cubs.

The minimum home range of no. 5, a male, was similar to that of no. 6. Movement of this male, however, appeared more extensive than in the case of the female. On one day it was tracked from Holt 6 to Holt 11 (west of Holt 5). That night it had moved a distance of at least 5 km. Indications were that it had passed this holt. The only other case where movement of this otter could be traced, was when it was fed a marked fish after having been captured in Holt 3. The beads were recovered at Holt 1 the following day. Tracks of this otter were occasionally identified in all holts in the main study area, except Holt 4. Recognition of tracks in holts however, was only rarely possible, and it most probably visited Holt 4 too.

Apart from the one case mentioned, the use of marked fish proved completely unsuccessful. Fish were often not taken, because no otter was present at the holt where it was placed. In other cases the fish was taken by genets, water mongooses or seagulls. As the bait was usually placed on patches of sand, the culprit could be easily identified.

Beads fed to captive otters in fish were always recovered from spraints. It is therefore regarded as unlikely that beads were not ingested. The only alternative was that the faeces could not be found. This could be due to several reasons.

First, spraints could be deposited on rocks in the sea and therefore lost. This is unlikely, as otters were never seen to defaecate anywhere else than on land. Secondly, the spraints may have been deposited in the bush where they could not be located. This alternative was more likely, but still some spraints at sprainting sites should have contained at least a few beads. The last alternative was that otters moved out of the main study area and deposited their spraints elsewhere.

A combination of alternatives 2 and 3 was probably responsible for the disappearance of beads. It is suggested that the disappearance indicated that otters generally moved long distances along the coast. The chance of recovering beads taken within the study area would then be very small. Females with cubs would be an exception, as it was already shown that female no. 6, resident in the study area, tended to move small distances at a time with her cubs.

Measurement of the width of tracks gave some indication of approximate size of an otter, but proved completely unreliable in identifying individuals. Patches of sand where tracks were left, were few and far between, and the texture of the sand varied considerably. On the same area of sand a spoor was often measured from 75 to 90 mm, depending on the texture and moisture content of the sand.

The ratio of the distances between tracks proved reliable. The ratio for male no. 5 was on average 1 : 3 : 4 : 2, while for female no. 6 it was on average 2 : 2 : 5 : 2. Both these otters were identifiable from the burnt toes, and the above ratios were determined from repeated measurements. The ratios for no. 5 were determined from 16 measurements, and variations which occurred a total of 7 times were 2 : 3 : 4 : 2, 1 : 3 : 5 : 2 and 1 : 3 : 4 : 3. Ratios for no. 6 were determined from 10 measurements, and variations recorded 6 times were 2 : 2 : 5 :1, 1 : 2 : 5 : 2, 2 : 2 : 5 : 1 and 2 : 1 : 4 : 1.

A third otter recorded frequently, had the average ratio 5 : 2 : 2 : 2, with variations 5 : 1 : 2 : 1, 5 : 2 : 1 : 2, 5 : 2 : 3 : 2, 5 : 1 : 2 : 2 and 5 : 2 : 1 : 3. This was suspected to be no. 1, because this otter had been caputred three times within the main study area.

Although some variation in ratios did occur, the abovementioned otters were easily distinguishable from one another. The measurements were mostly made in the sandy gully at Goudgate, and frequently more than one set of measurements could be taken. The average of three measurements was used where possible and was usually the same as the predetermined average.

From 1 January to 31 March 1978 otter no. 5 was recorded in the gully 17 times, no. 6 7 times and the other one (no. 1?) also 17 times. Eight other sets of measurements were taken which could have been variations of the above three ratios, or could have been other otters. These ratios were 3 : 2 : 4 : 1, 0 : 4 : 4 : 3, 6 : 0 : 3 : 1, 3 : 2 : 5 : 0, 3 : 3 : 1 : 3, 4 : 2 : 1 : 2, and 4 : 3 : 0 : 3. The last ratio was recorded twice. At least three of these ratios (0 : 4 : 4 : 3, 3 : 3 : 1 : 3 and 4 : 4 : 0 : 3) were probably different otters, while the others may have been variations of the three known otters.

The above mentioned tracks were only the measurable ones. Apart from these, 30 other rows of tracks were found during the period which could not be measured. This was when the sand was disturbed from frequent walking by tourists, or when several otters crossed the gully during the same night. On one night for example, there were four rows of tracks in one direction and three in the other.

On 174, or 58% of 300 days that the gully was checked, tracks were present. The total number of rows present during this period was 287; 157 from west to east and 145 from east to west. This means that the number of rows per night was on average 0,96, i.e. about one, while movement in the two directions was about equal. The same track was often found in both directions, indicating that the otter had moved along the coast some distance and then returned.

Occasionally tracks were also recorded in another sandy gully between Holts 4 and 5. Fourteen rows of tracks between January and March 1978 were measurable. Eight of these belonged to no. 5 (ratio 1 : 3 : 4 : 2), four to no. 6 together with her cub, one to the other otter (5 : 2 : 2 : 2) and one possibly to an unknown otter (0 : 2 : 5 : 2). Tracks of this last otter appeared fairly small, while they were found on the same night and in the same direction as the tracks of no. 5. This otter may have been the cub of no. 6, possibly walking together with no. 5. It need not necessarily have walked together with no. 5, as the time at which otters had walked there could not be determined.

The conclusion that may be drawn from the data from these sandy gullies is that mainly three otters frequented the area; a male (no. 5), a female (no. 6), and an unidentified otter which was probably another female (no. 1). Occasionally other otters apparently passed through the area. This correlated with the repeated capture of otters 1, 5 and 6 in the main study area, whereas all other otters, all males, were captured only once.

Movement over long distances by males has been suggested previously. Both Maxwell (1960) and Tayler (1970) mentioned distances of 13 km per night for Aonyx. Erlinge (1967) reported that females of Lutra lutra with cubs in Sweden had home ranges of about 7 km in length, while those of males had a length of about 15 km. The males travelled on average about 9 to 10 km per night. He found that the sizes of home ranges depended to a large extent on the presence of other, especially male otters.

Unfortunately the use of measurements of distances between tracks was restricted to these two gullies. Similar gullies were extremely rare along the rest of the coast, and when they were present, they were not always used to the same extent as the gully at Goudgate. Small patches of sand could seldom be used for this purpose, because the length of a stride varied from about 600 to 900 m, while the patches of sand were often small.

Otters apparently do not specifically favour large rivers. They were frequently seen at the mouth of rivers, but seldom deeper in. At Lottering River Mouth the Ranger always saw otters moving from their holt at the mouth to the open sea and vice versa. They were never seen to swim up the river. This holt was situated around a pool of fresh water above a short gully entering the river, and otters entered the holt via this gully. At this point the water of the river was always brackish. The Bloukrans River Mouth may have had a similar holt. Tracks at Elandsbos River Mouth indicated that otters seldom, if ever, moved up the river. The otters that moved across the beach at Nature's Valley often went to a small spring, supposedly to drink water, then returned to the sea. In other cases they went into the Groot River Lagoon, swam around some time, (this was once observed by the Ranger), then returned to the sea. No evidence of otter activity could be found higher up this river.

The otter seen at night by Dr Robinson in a gully cut into the Storms River gorge, and the occasional spraints found at the bottom of this gully, did indicate that otters occasionally moved up the river. The three spraints found at the above mentioned gully all contained remains of marine organisms. The otters moving up the river may have done so out of curiosity, or perhaps it may have been part of territorial behaviour.

Regular movement between the coast and inland rivers is regarded as unlikely. If it existed at all, it was probably limited. Some more accessible stretches of the larger rivers were searched, but apart from one otter track at the old bridge over the Storms River and a track much higher up in the Forestry area, no signs of otters could be found.

## AN ESTIMATE OF POPULATION SIZE

This section will be an integration and discussion of evidence mentioned in the previous sections. No separate techniques are therefore applicable.

At least 51 holts were found along the coast of the Tsitsikama National Park. Another possible 14 were mentioned. The minimum and maximum number of holts would therefore be 51 and 65. Straight-line length of the Park is about 60 km, giving an average density of between 0,9 and 1,2 holts per kilometre.

In the first section of this chapter, average utilisation of the five holts in the main study area was calculated at 32,3%, which was taken to mean that there were about three holts to every otter.

By multiplying the above percentage utilisation with the minimum and maximum number of holts, an estimate of between 17 and 21 otters was obtained for the whole coast. This equalled one otter to every 2,9 to 3,5 km (straight-line distance) of coastline. How reliable is this estimate?

The assumption was made that the utilisation pattern of holts along the whole coast was the same as that of the main study area. There was no evidence to prove the contrary. Holts 6, 7, 8, 9, 10, 11 and 12 (Figure 41)were studied fairly regularly, and the pattern of utilisation appeared similar to that of the main study area. Altogether a stretch of about 15 km, or $\frac{1}{4}$ of the total coastline was fairly well studied. Furthermore the number of spraints initially found at all holts, nearly always varied from about 30 to 50, in, as well as out of the study area. If the pattern of utilisation was significantly different along different sections of the coast, significantly different numbers of spraints would be expected. This assumption is therefore taken to be valid.

Several uncertain factors were mentioned before, which could have caused under- or overestimation of the utilisation of holts. Some of these probably neutralised each other. It is felt that the factors causing underestimation may have been more important than those causing overestimation. The ratio of holts : otters could therefore probably be a little bit less than 3,1 : 1, but it is unlikely to be less than about 2,5 : 1 (equivalent to 40% utilisation).

The confidence limits for the number of holts along the coast (51 and 65) are regarded as very accurate. Evidence for this has been discussed before.

If it is accepted that the ratio holts : otters may vary down to 2,5 : 1, the maximum population size would then change to 26, while minimum population size mentioned before was 17.

The accuracy of this estimate is impossible to define in statistical terms. From previous reasoning however, the limits of 17 and 26 are regarded as reliable.

Although the estimate of population size calculated by means of this method is regarded as fairly accurate, it is advisable to compare it with other evidence as a means of checking accuracy.

During March 1978 the adjacent home ranges of two females with cubs covered a total length of coastline of about 13 km. At least for the female in the main study area it must have been more. A figure of 7 km could be regarded as the minimum home range of a female with cubs. This would mean that there could be a maximum of about eight to nine females with cubs along the whole coast. If these were the only females, and there were to be a male for each, population size would be 16 to 18. This is the same as the minimum estimate mentioned before. It is likely to be more, because some females apparently do not have cubs, at least not every year. This was suggested by the repeated capture of female no. 1.

Male no. 5 was apparently residential within a strip of at least 3 km; probably more. If there were one male to every 3 km, with a sex ratio of 1 : 1, population size would be 40. This is higher than the maximum estimate of 26, but still more or less of the same order. Furthermore it is bound to be too high because the "territories" of males are probably larger than 3 km. With the data available, the estimate of 26 is far more reliable than 40.

These arguments were meant as support for the estimate of population size, not as separate estimates. Lack of data precluded this.

It should be emphasised that the estimate of 17 to 26 is for adult otters only. During the first four months of 1977 at least four juveniles were present in the western section of the Park alone. During the first three months of 1978 the figure for the central section of the park was at least three. The maximum number of females with cubs at any time has been estimated at eight to nine. If each of them were to have one or two cubs (see next chapter), there would be eight to 18 juveniles. Available evidence indicates that the number was probably lower. At any time therefore, there could be from about four to eighteen juveniles in the study area. If these are added to the adult population, a population size of 21 to 44 results. The figure of 21 is probably too low, while 44 is regarded as too high, but they are regarded as good confidence limits for an estimate of which the accuracy is not all that high.

The juveniles are included in the estimate, because they grow fairly fast and soon reach adult proportions. They therefore probably consume about just as much food as the adults a few months after birth.

The final estimate of population size is now between 17 and 26 adult otters along the whole coast of 60 km. This equals one otter to every 2,3 to 3,5 km. The estimate for juveniles is between four and eighteen, or one to every 3,3 to 15 km. When the two are combined, total population size is estimated to have been 21 to 44 otters, or one otter to every 1,4 to 2,9 km of coastline. The average of these two estimates would be 33 otters, or one otter to every 1,8 km of coastline.

Until a better method of estimating population size can be found or assumptions used for the estimate definitely proved wrong, a rough estimate of about one otter per 2 km of coastline is postulated.

When compared with estimates of density of other otter species, the population size of _Aonyx capensis_ at Tsitsikama appears to be high. Erlinge (1968) reported one individual of _Lutra lutra_ per 2 to 3 km on lake shores in Sweden, while the density along streams was one per

5 km. In one particular lake the density was estimated at one otter per 1,8 km. This was regarded as extremely high, and as the cause of a low population of minks (Erlinge 1969).

Tayler (1970) reported seven adult otters along a stretch of coast of about 35 km in the vicinity of Port Elizabeth, i.e. about one otter to every five kilometres. The evidence on which his estimate was based however, was probably suspect.

Macdonald et al. (1978) estimates the number of Lutra lutra along the Teme River catchment in England at about 12. The total length of the catchment rivers was 343 km. This density of about one otter per 29 km was regarded as far below the potential carrying capacity.

Kruuk and Hewson (1978) gave no actual estimate of density of Lutra lutra along the Scotland coast, but they thought that there were more than one per 2 to 3 km. They postulated that the optimal habitat of the otters is marine, rather than inland waters.

No estimate of population size of Aonyx capensis has been made anywhere in Africa to compare with the present estimate. I tend to agree with Kruuk and Hewson (1978) however, that a marine habitat is probably the optimum habitat for otters, provided that, as in the case of the Tsitsikama coast, enough fresh water and shelter is available. The present population size is probably the optimum size, and it is suggested that, rather than food, shelter and fresh water, territorial behaviour may be the factor limiting further growth. Some or all of the first three factors may have been responsible for the apparently low density in the Port Elizabeth area (Tayler 1970), although the additional factor of human interference, as suggested, may also be of importance there.

# REPRODUCTION AND MORTALITY

## INTRODUCTION

Factors of increase and decrease of a population are important when considering the status of an animal; hence the inclusion of this chapter, although no specific attempt was made to collect data on this. During the course of events however, some data became available which proved valuable. Apart from my own observations, some reports on reproduction and mortality were found in the literature.

No specific materials or methods were used, as all the data came from methods used for other purposes.

## RESULTS AND DISCUSSION

Four records of females with cubs have been mentioned before. One female twice had cubs during the study period : first a litter of two in 1977 and later a single cub in 1978. A female with two cubs was seen at Holt 8 as well as Holt 10 (Figure 41). It was assumed to be the same group. Another female with two cubs was tracked between Holts 7 and 14, although they were not actually seen. A group of four otters, which may have been a female with three cubs, or a male, female and two cubs, was once seen by a Ranger near Lottering River.

From the above it would appear that average litter size in Tsitsikama was about two. Three definite cases of two cubs and one case of one cub provided the evidence.

Normal litter size inland appears to be two to three (Fitzsimmons 1919, Shortridge 1934). Shortridge mentions a few cases of four cubs and one of five, all in the Vaal River. Dorst and Dandelot (1970) give litter size as two to five, and gestation period as two months.

Litter size of the coastal otters is probably not significantly different from that of inland otters, but lack of data precludes any definite conclusion.

It has been suggested that the population size of Aonyx along the Tsitsikama coast is at its optimum. Maximum number of females with cubs at a particular time was estimated at eight to nine. With an average litter size of two this would mean a maximum of 16 to 18 cubs per year, which is probably more than needed by the population.

The first two cubs were seen late in January 1977, and were probably born early in January or late in December. The cub seen in February and March 1978 was estimated to have been born in January. The tracks of the two cubs seen together with their mother east of Storms River Mouth were seen in March 1978 and appeared small. These two cubs may also have been born in January or February. The age of the two cubs seen together with their mother between Holt 8 and Holt 10 was impossible to estimate. They may have been a year old already.

The data mentioned indicate that the breeding season at Tsitsikama is probably midsummer. The tame otter was given to Dr Robinson in April 1978, at which time its eyes were not yet open. Reports from the literature are virtually non-existent. The only one that could be found was Eyre (1960), who found a baby otter in October in the South Western Cape Province. It may be that regional differences in breeding season exist, but indications are that breeding is seasonal.

Seasonality of breeding would be an adaptation towards life in inland waters which often dry up in winter. It has been shown however, that the prey populations of otters in the sea do not vary considerably. There would therefore not seem to be much need for a seasonal breeding season. It is of interest that the sea otter Enhydra lutris, having completely adapted to a marine existence, breeds throughout the year (Kenyon 1971).

Emigration possibly occurred, either further along the coast or inland. Data to prove or disprove this are lacking, but if otters inland or further along the coast were in equilibrium with their environment, it would be unlikely.

It has been mentioned before that a female with two cubs was once apparently forced to hunt in very rough water. One of the cubs was subsequently found on land by tourists in a very exhausted condition. It died during that night. On another occasion a dead otter was reported by hikers along the beach near Geelhoutbos River Mouth. One of the hikers had a knowledge of zoology and was positively sure about the identification.

It would appear that the sea may be an important mortality factor. Predation on cubs is regarded as unlikely, but cannot be excluded. The only potential terrestrial predators present were leopard, which were rare, and caracal (Robinson _pers. comm._). Sharks may possibly catch the odd cub. Reports of predation on otters in the literature are rare. Stevenson-Hamilton (in Shortridge 1934) once saw a crocodile immediately seizing a wounded otter. Randall (_pers. comm._) reported that where crocodiles were abundant, otters were often rare or absent, but according to Shortridge (1934), otters hold their own in crocodile-infested waters. No reports on other predators or potential predators were found.

## CONCLUSIONS

The relatively high density of Cape clawless otters along the Tsitsikama coast in comparison with the few estimates of densities of otters all over the world, excluding the true sea otters, appears to strengthen the argument of Kruuk and Hewson (1978) that the sea is an optimum habitat for otters. It would appear, however, as if this high density is restricted to the Tsitsikama section of the South African coast.

Three factors of importance to otters along the coast have emerged from this study : food, shelter and fresh water. A quantitative comparison between the faunas of fresh water and the marine littoral would be difficult, but subjectively the density of crabs along the Tsitsikama coast appeared much higher than in the rivers and streams of the southern Cape. These "black waters" have a very low pH and a high concentration of humic acids, resulting in a depauperate fauna (Tinley* pers. comm.). Apart from the crabs, a much greater number and diversity of other prey is present in the sea. The availability of food along the coast therefore appears much higher than in inland waters. Most of this coastal fauna, however, is restricted to rocky areas, so that large stretches of South African coast would be unsuitable in this respect.

Holts generally appear to be situated in dense bush, and it has been mentioned previously that this is plentiful along the Tsitsikama coast.

The most important limiting factor is possibly the presence or absence of fresh water. The Tsitsikama coast is one of the best watered parts of the South African coast. The coast near Port Elizabeth, for example, which had a much lower density of otters (Tayler 1970), also has a limited supply of fresh water in the form of a few marshy areas. Another possible factor of importance in this case, however, as suggested by Tayler (1970), was disturbance by people.

A combination of the above mentioned factors, together with a lack of disturbance, is regarded as the reason for the relatively high density of otters in the Tsitsikama coastal National Park. For the same reason it is regarded as unlikely that otters have ever been, or will ever be common along most of the South African coast, even without human interference.

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The absence of morphological differences between coastal and inland otter populations suggested there is some contact between them, although no evidence of movement was found. The coastal population most probably arose from the inland stock, and it is thought unlikely that otters would leave such a favourable environment as the Tsitsikama coast unless forced to. Social behaviour might perhaps force the occasional individual to move inland, while the occasional dominant inland individual might replace individuals of the coastal population. Without any factual information, however, this remains pure speculation.

The only proposal for management of otters in the Tsitsikama coastal National Park is that they be left alone. They are an attraction to tourists, and have virtually no effect on angling fish. They may perhaps even enhance species diversity. A decline in numbers is regarded as unlikely as long as there is no human interference at the holts. No evidence could be found that hikers on the "otter trail" have any negative influence on otters. Even a considerable increase in the number of people on the trail is unlikely to have an effect, as the otters are sheltered very effectively by the dense bush. Only destruction of the bush, which is unlikely, would possibly have a deleterious effect.

Possible future research topics are, e.g. the study of the social behaviour of otters and its effect on population size. Without this knowledge it is not yet possible to state with certainty whether the population size of Aonyx along the Tsitsikama coast is at its optimum. Another study which might elucidate the role of otters in the marine littoral community, would be an autecological study of Plagusia chabrus, with emphasis on productivity and mortality factors other than otters.

The importance of crabs in the diet of coastal otters may be the result of a continued inherited specialization, or it may simply be the opportunistic utilization of ecological dominants. The most likely is a combination of the two factors.

SUMMARY

Except for the European/British otter *Lutra lutra* and the North American/ Canadian otter *L. canadensis*, the state of knowledge on otters of the world is very limited. In Britain otters have declined to such an extent that research on them is now very difficult. In South Africa *Aonyx capensis* is still common, and the Tsitsikama coastal National Park was in many respects an ideal area for studying the species, which is a furbearer of commercial importance.

Little confusion exists around the taxonomy of the Cape clawless otter, and the name *Aonyx capensis* (Schinz, 1821), with three subspecies, is generally accepted.

*Aonyx capensis* occurs throughout most of Africa south of the Sahara wherever there is perennial water available, except in the Congo Basin, where it is apparently replaced by *A. congica*.

Coastal otters appeared relatively small in comparison to inland otters, but this was not significant, and possibly the result of size-selective trapping (very large individuals avoiding the traps).

The study area was the Tsitsikama coastal National Park; about 60 km of coast along the Indian Ocean. The coast rises about 180 m to a wave cut plateau. Rainfall is about 913 mm per year at the coast and temperatures are moderate throughout the year. The steep slopes of the escarpment are mainly covered by dry shrub and forest.

The food of *Aonyx* along the Tsitsikama coast was determined by spraint (faeces) analysis. Analysis was done by frequency of occurrence of remains in spraints as well as by weight composition of spraints. The merits and disadvantages of both methods were discussed, and for a final estimate of relative numbers and biomass of prey taken a combination of the two methods was used. Estimates of availability of prey were based on sampling certain areas along the coast with the ichthyocide rotenone. The two main sampling areas were a small intertidal pool sampled once every season, and a general subtidal area where a different subsection was sampled every season. Estimates of consumption were combined with estimates of availability in Ivlev's (1961) electivity index to express selection quantitatively.

According to the final estimate, about 81% of all prey animals (equal to about 87% of total biomass consumption) consisted of four species. These were Plagusia chabrus (red rock crab), Octopus granulatus, Chorisochismus dentex (suckerfish) and Cyclograpsus punctatus (brown rock crab). The other 19% (13% of biomass) consisted of at least 38 species. The estimates of proportions of total number of animals taken were : Plagusia 42,3%, Cyclograpsus 25,7%, Chorisochismus 9,2% and Octopus 3,7%. Estimates of contribution to biomass of prey were : Plagusia 36,1%, Octopus 34%, Chorisochismus 10,7% and Cyclograpsus 5,9%.

Plagusia appeared to be the most positively selected prey species (E = +0,4), followed by Chorisochismus (E = +0,2) and Octopus (E = +0,1). Cyclograpsus was not taken into account because it was not represented in the sampling areas. Clinidae appeared to be strongly negatively selected (E = -0,6).

Monthly variation in the relative importance of prey species occurred, but usually not markedly so. In the case of Cyclograpsus it could have been due to positive selection of the species in late summer by female otters with cubs too young to swim. For the other species no clear explanation could be found, but it was probably just a form of sampling error because of the extreme heterogeneity of the inter- and subtidal zones. This was deduced from the observation that considerable variation in relative importance occurred between individual holts.

Certain size classes of all prey species were selected above others. The smaller size classes of all the main prey species were heavily selected against. Medium-sized Plagusia were preferred, with few very large crabs taken, whereas in the other three principal prey species, as well as the Clinidae, larger individuals were apparently preferred. In the case of spariform fishes, mainly juveniles were taken, although adults were common in the infratidal area.

By comparing the relative importance of size classes of the principal prey species with the distribution in the sampling areas, it was concluded that Plagusia was probably hunted mainly in the intertidal area, while Octopus and Chorisochismus were probably hunted more in the subtidal area. Cyclograpsus was more or less restricted to the Littorina zone.

Apart from the four principal prey species, freshwater crab, lobster, frogs, and at least 30 species of fish were included in the diet. A few other items of which remains were found in spraints had probably been part of the stomach contents of prey animals.

Hunting was mostly done along rocky ridges. Dives were always less than a minute ($\bar{n}$ = 25 ), while food was mostly eaten in the sea with the head above water. Indications were that Aonyx needs fresh water to drink. Activity was predominantly at night, but otters were seen throughout the day. The state of the tide appeared to have little influence on activity patterns.

A minimum estimate of daily food consumption per individual of 2 kg was postulated. This estimate was combined with estimates of relative numbers and biomass taken and population size of otters to yield an estimate of about 400 kg/km total annual food consumption along the coast.

Aonyx was concluded to be essentially an opportunistic feeder.

Otters were captured mainly by means of standard caracal traps, and trapping success of these traps was 8,3%. Two lightweight home-made traps had a trapping success of only 2%. Overall success was 7,1%. Plastic ear markers, as well as freeze branding proved unsuccessful for field identification. A combination of the drug Ketamine hydrochloride and the tranquillizer acetopromazine proved ideal for immobilization.

Nine individual otters were caught 19 times. Of these, a male and two females were repeatedly captured, while all others were males captured only once.

51 Definite holts and another possible 14 were found along the coast of about 60 km, all of them associated with fresh water. Average straight-line distance between them was 1 km (0,3 - 2,4 km). Seven of these holts were studied in detail, while at five of these, activity was determined throughout the study period. Surface area of these holts varied between less than about 3 000 $m^2$ to possibly more than about 10 000 $m^2$. Shelter was always available in the form of dense vegetation.

Average utilisation per holt over the study period was estimated at 19% to 44%, with an average of 32,3%. This was about the same range as between individual holts. An estimate of density of otters of 1 per 3 holts was therefore obtained, but this was based on four assumptions : that otters always left signs when visiting a holt, that the presence of sign always indicated the presence of an otter in the holt, that otters use only holts to sleep during the day, and that only one otter visited a holt at a time. Evidence was led to prove these assumptions at least generally true. There was mostly a correlation between sight records of otters and the presence of sign at a holt. Sign was apparently mostly left only when entering a holt. Nearly 80% of all sight records of otters were of single individuals, while most of the other records were of females with cubs.

Minimum home ranges of three females with cubs were estimated at 6,5 km, 5 km and 4 km. These groups apparently moved short distances at a time. Indications were that at least males moved long distances along the coast.

Measurement of tracks indicated the regular presence of three individuals within the main study area. Two of these, and probably the third one too, were the same as those repeatedly captured.

There were estimated to be between 21 and 44 individuals (including juveniles) along the coast of the National Park, which would be 1 per 2,9 to 1,4 km. These were regarded as reliable confidence limits for a final estimate of 1 otter per 2 km of coastline.

Average litter size at Tsitsikama appeared to be two, mainly arriving in midsummer. Rough seas were postulated as being the main mortality factor of coastal otters. No evidence of predation could be found.

The abundance of <u>Aonyx capensis</u> along the Tsitsikama coast is probably the result of a combination of ample food, fresh water and shelter.

OPSOMMING

Behalwe vir die Brits-Europese otter Lutra lutra en die Noord-Amerikaans-Kanadese otter L. canadensis, is daar min oor otters in die wêreld bekend. In Brittanje is daar nou só min otters, dat navorsing op hulle baie moeilik is. In Suid-Afrika kom Aonyx capensis nog algemeen voor en die Tsitsikamaseekus Nasionale Park was in baie opsigte 'n ideale studiegebied.

Daar heers min verwarring oor die taksonomie van die groototter, en die naam Aonyx capensis (Schinz, 1821), met drie subspesies, word algemeen aanvaar.

Aonyx capensis kom voor dwarsdeur die grootste gedeelte van Afrika suid van die Sahara waar standhoudende water is, behalwe in die Kongo bekken, waar A. congica voorkom.

Otters wat langs die kus voorkom blyk klein te wees in vergelyking met otters in die binneland. Hierdie verskil is egter nie beduidend nie en is heel moontlik as gevolg daarvan dat baie groot individue die vanghokke vermy.

Die studiegebied was die Tsitsikamaseekus Nasionale Park, 'n kusstrook van ongeveer 60 km langs die Indiese Oseaan. Direk aangrensend aan die kus is 'n branderstoep met 'n hoogte van ongeveer 180 m. Reënval by die kus is ongeveer 913 mm per jaar en temperature is matig dwarsdeur die jaar. Die steil hellings van die eskarpementrand is hoofsaaklik dig begroei met droë struikbos en woud.

Aonyx se voedsel by die Tsitsikamakus is bepaal deur misontledings. Ontledings is gedoen deur vas te stel wat die frekwensie voorkoms van die oorblyfsels was, asook deur gewigsamestellings van die mis. Die voor- en nadele van beide metodes is bespreek. Om finaal te skat hoeveel prooi gevang is en wat die biomassa daarvan was, is 'n kombinasie van die twee metodes geneem. Om te skat wat die beskikbaarheid van prooi was, is 'n paar plekke langs die kus vergiftig met rotenone. Die twee belangrikste proefareas was 'n klein tussengetypoel wat eenmaal per seisoen vergiftig is, en 'n algemene area in die infragetysone waarvan elke seisoen 'n ander deel vergiftig is. Skattings van verbruik is verbind met skattings van beskikbaarheid deur Ivlev (1961) se elektiwiteitsindeks om seleksie kwantitatief uit te druk.

Die finale skatting was dat omtrent 81% van alle prooidiere (gelykstaande aan ongeveer 87% van die totale biomassa verbruik) uit vier spesies bestaan, naamlik Plagusia chabrus (rooi rotskrap), Octopus granulatus (seekat), Chorisochismus dentex (suiervis) en Cyclograpsus punctatus (bruin rotskrap). Die ander 19% (13% van die biomassa) het uit minstens 38 spesies bestaan. Die skattings van die totale aantal prooidiere gevang, was : Plagusia 42,3%, Cyclograpsus 25,7%, Chorisochismus 9,2% en Octopus 3,7%. Na raming was die bydrae van die prooidiere tot die biomassa : Plagusia 36,1%, Octopus 34%, Chorisochismus 10,7% en Cyclograpsus 5,9%.

Plagusia was die mees positief geselekteerde prooispesies (E = +0,4), gevolg deur Chorisochismus (E = +0,2) en Octopus (E = +0,1). Cyclograpsus is nie in ag geneem nie, omdat dit nie in die steekproefgebiede voorgekom het nie. Clinidae is klaarblyklik sterk negatief geselekteer (E = -0,6).

Daar was 'n moontlik onbeduidende maandelikse variasie in die relatiewe belangrikheid van prooispesies. In die geval van Cyclograpsus kan dit wees as gevolg van die positiewe seleksie vir hierdie spesie in die laat somer deur wyfies met kleintjies wat nog te jonk was om te swem. Daar is geen goeie verduideliking vir die variasie van die ander spesies nie, maar dit kon moontlik net die gevolg wees van 'n steekproef wat te klein was om die geweldige verskeidenheid van die inter- en infragetysones te kanselleer. Dit is afgelei van die waarneming dat daar groot variasie was in die relatiewe belangrikheid tussen individuele skuilplekke.

Sekere grootteklasse van alle prooispesies is bo ander geselekteer. Daar is kwaai teen die kleiner grootteklasse van al die hoof prooispesies geselekteer. Plagusia van middelmatige grootte is verkies met 'n paar baie groot krappe daarby, terwyl by die ander drie belangrike prooidiere, sowel as die Clinidae, groter individue klaarblyklik verkies is. In die geval van Sparidae en soortgelyke visse, is hoofsaaklik kleintjies gevang, terwyl volgroeides algemeen in die infragetysone voorgekom het.

Deur die relatiewe belangrikheid van grootteklasse van die belangrikste prooispesies te vergelyk met die verspreiding in die vergiftigde gebiede, is afgelei dat *Plagusia* waarskynlik hoofsaaklik in die tussengetysone gejag is, terwyl *Octopus* en *Chorisochismus* waarskynlik meer in die infragetysone gejag is. *Cyclograpsus* was hoofsaaklik beperk tot die *Littorina* sone.

Behalwe die vier belangrikste prooidiere, bestaan die dieet van otters ook in mindere mate uit varswaterkrappe, kreef, paddas en minstens 30 visspesies. Ander oorblyfsels wat in die mis gevind is, was waarskynlik deel van die maaginhoude van prooidiere.

Daar is hoofsaaklik langs rotsriwwe gejag. Die otters het altyd vir minder as 'n minuut geduik ($\bar{n}$ = 25), terwyl die kop meestal bo water gehou was wanneer die prooi geëet is. *Aonyx* blyk vars water nodig te hê om te drink. Hulle is deur die dag gesien, maar hulle was hoofsaaklik snags aktief. Watter gety dit was, het blykbaar min invloed op aktiwiteitspatrone gehad.

Daar is beraam dat 'n minimum van 2 kg voedsel per dag deur 'n individu verbruik is. Hierdie skatting is gekombineer met die relatiewe aantal en biomassa van die prooi wat geneem is, en die geskatte grotte van die otterbevolking. Die resultaat is 'n skatting van ongeveer 400 kg/km totale voedselverbruik per jaar langs die kus.

Daar is tot die slotsom gekom dat *Aonyx* in wese 'n opportunistiese jagter is.

Otters is hoofsaaklik in standaard rooikatvanghokke gevang. Vangsukses op die manier was 8,3%. Sukses met twee ligte tuisgemaakte vanghokke was slegs 2%. Totale sukses behaal was 7,1%. Plastiese oormerkers, asook vriesbrand, was onsuksesvol om otters in die veld uit te ken. Die verdowingsmiddel Ketamien hidrochloried en die kalmeermiddel acetopromazien was 'n ideale kombinasie vir verdowing.

Nege individuele otters is 19 keer gevang. Een mannetjie en twee wyfies is herhaaldelik gevang, terwyl al die ander otters mannetjies was wat slegs eenmaal gevang is.

51 Definitiewe skuilplekke en nog 14 moontlike skuilplekke is langs die kus van omtrent 60 km gevind. Almal was by vars water. Die gemiddelde afstand tussen die skuilplekke was 1 km (0,3 - 2,4 km). Sewe van hierdie skuilplekke is fyn bestudeer, terwyl aktiwiteit by vyf van hierdie skuilplekke vasgestel is. Hierdie skuilplekke se oppervlakte het gevarieer tussen minder as 3 000 m tot moontlik meer as 10 000 m . Skuiling was altyd beskikbaar in die vorm van digte plantegroei.

Gemiddelde verbruik per skuilplek gedurende die studieperiode is geskat op 19% tot 44%, met 'n gemiddeld van 32,3%. Die variasie was ongeveer dieselfde as tussen individuele skuilplekke. Gevolglik is geskat dat daar een otter vir elke drie skuilplekke is, maar dit is gebaseer op vier aannames : dat otters altyd tekens los as hulle by 'n skuilplek was, dat die teenwoordigheid van 'n teken aandui dat daar 'n otter in die skuilplek is, dat otters slegs skuilplekke gebruik om bedags in te slaap, en dat slegs een otter op 'n slag 'n skuilplek besoek. Daar was bewyse dat hierdie aannames oor die algemeen waar was. Sigrekords van otters by skuilplekke het meestal met die teenwoordigheid van tekens gepaard gegaan. Tekens is blykbaar hoofsaaklik gelaat tydens die binnegaan van 'n skuilplek. Ongeveer 80% van alle sigrekords was van enkele individue, terwyl die meeste ander van wyfies met kleintjies was.

Die minimum loopgebiede van drie wyfies met kleintjies is geskat op 6,5 km, 5 km en 4 km. Een van die groepe kon af en toe gevolg word en het kort afstande op 'n slag beweeg. Daar was aanduidings dat ten minste die mannetjies lang afstande langs die kus af beweeg.

Deur spore te meet, is gevind dat drie individue gereeld binne die hoofstudiegebied beweeg. Twee van hulle, en dalk ook die derde een, was dieselfde individue wat herhaaldelik gevang is.

Na raming was daar tussen 21 en 44 individue (kleintjies ingesluit) langs die kus van die Nasionale Park, dit wil sê een per 2,9 tot 1,4 km. Hiervolgens is die finale skatting ongeveer een otter per 2 km kuslyn.

Die gemiddelde werpselgrootte by Tsitsikama was twee. Geboorte het hoofsaaklik in die somer plaasgevind. Die belangrikste mortaliteitsfaktor is moontlik rowwe see. Daar is geen bewys van predasie op otters gevind nie.

Die kombinasie van genoegsame voedsel, vars water en skuiling is waarskynlik die rede waarom groototters so volop langs die Tsitsikamakus is.

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APPENDIX 1

Statistical information on regressions used in the study.

| Species | | X | Y | Regression | R | $R^2$ | F | Deg. of Freedom | S.E. of estimate |
|---|---|---|---|---|---|---|---|---|---|
| Plagusia chabrus | male | Ch | C | $Y = 1,938\ X^{0,966}$ | 0,938 | 0,967 | 2759 | 95 | 0,0302 |
| | | F | C | $Y = 7,5451\ X^{0,6663}$ | 0,953 | 0,908 | 357 | 36 | 0,0311 |
| P. chabrus | female | Ch | C | $Y = 1,4583\ X^{1,0918}$ | 0,992 | 0,938 | 5017 | 86 | 0,0292 |
| | | F | C | $Y = 3,1243\ X^{1,0669}$ | 0,994 | 0,988 | 6740 | 85 | 0,0258 |
| | | C | W | $Y = 0,001\ X^{2,8022}$ | 0,992 | 0,984 | 5979 | 98 | 0,0604 |
| Cyclograpsus punctatus | male | Ch | C | $Y = 3,911\ X^{0,6198}$ | 0,960 | 0,961 | 273 | 11 | 0,0166 |
| | | F | C | $Y = 6,2474\ X^{0,5617}$ | 0,973 | 0,947 | 251 | 14 | 0,0200 |
| C. punctatus | female | Ch | C | $Y = 1,9337\ X^{0,9689}$ | 0,953 | 0,909 | 110 | 11 | 0,0215 |
| | | F | C | $Y = 3,2626\ X^{0,9891}$ | 0,936 | 0,926 | 154 | 12 | 0,0203 |
| | | C | W | $\text{Log}\ Y = 0,0659\ X - 0,7782$ | 0,997 | 0,993 | 862 | 6 | 0,0404 |
| Octopus granulatus | | Ob | L | $Y = 22,5367\ X^{1,0826}$ | 0,994 | 0,986 | 1061 | 13 | 0,0350 |
| | | Ib | L | $Y = 28,5509\ X^{1,0971}$ | 0,995 | 0,990 | 1346 | 13 | 0,0312 |
| | | L | W | $Y = (4,2638 \times 10^{-5})X^{2,571}$ | 0,994 | 0,988 | 796 | 10 | 0,1260 |
| Chorisochismus dentex | | Pl | L | $Y = 10,3436\ X^{0,8299}$ | 0,994 | 0,987 | 1680 | 22 | 0,0128 |
| | | Pw | L | $Y = 10,0914\ X^{0,8945}$ | 0,985 | 0,971 | 736 | 22 | 0,0191 |
| | | L | W | $Y = (3,475 \times 10^{-5})X^{2,8737}$ | 0,990 | 0,981 | 3559 | 70 | 0,0994 |
| Clinus cottoides | | Pl | L | $Y = 13,6848\ X^{0,928}$ | 0,977 | 0,955 | 728 | 34 | 0,0277 |
| | | Pw | L | $Y = 26,2839\ X^{0,7781}$ | 0,963 | 0,928 | 438 | 34 | 0,0352 |
| | | L | W | $\text{Log}\ Y = 0,0202\ X - 0,9187$ | 0,993 | 0,985 | 4710 | 71 | 0,0505 |
| Clinus superciliosus | | Pl | L | $Y = 13,053\ X^{0,9468}$ | 0,992 | 0,984 | 2240 | 36 | 0,0178 |
| | | Pw | L | $Y = 26,8176\ X^{0,803}$ | 0,966 | 0,972 | 1235 | 36 | 0,0237 |
| | | L | W | $Y = (6,7 \times 10^{-6})X^{3,0922}$ | 0,993 | 0,986 | 2210 | 32 | 0,0528 |
| Clinus capensis | | Pl | L | $Y = 7,5673\ X^{1,2303}$ | 0,957 | 0,915 | 65 | 6 | 0,0211 |
| | | Pw | L | $Y = 23,9707\ X^{0,8969}$ | 0,925 | 0,856 | 36 | 6 | 0,0274 |
| | | L | W | $Y = 52,1459\ X^{0,3184}$ | 0,981 | 0,962 | 458 | 18 | 0,0152 |
| Pavoclinus graminis | | Pl | L | $Y = 15,1496\ X^{0,9506}$ | 0,986 | 0,972 | 614 | 18 | 0,0162 |
| | | Pw | L | $Y = 26,7128\ X^{1,1558}$ | 0,931 | 0,876 | 117 | 18 | 0,0350 |
| | | L | W | $Y = 43,4680\ X^{0,3604}$ | 0,986 | 0,972 | 1994 | 57 | 0,0310 |
| Pavoclinus pavo | | Pl | L | $Y = 13,9994\ X^{1,0055}$ | 0,855 | 0,730 | 14 | 5 | 0,0375 |
| | | Pw | L | $Y = 41;5470\ X^{0,6923}$ | 0,920 | 0,846 | 28 | 5 | 0,0283 |
| Blennius cornutus | | Pl | L | $\text{Log}\ Y = 0,1123\ X + 1,3718$ | 0,978 | 0,957 | 225 | 10 | 0,0238 |
| | | Pw | L | $Y = 28,653\ X^{0,7020}$ | 0,973 | 0,947 | 180 | 10 | 0,0265 |
| Gobius nudiceps | | Pl | L | $Y = 20,2255\ X^{0,8103}$ | 0,992 | 0,985 | 1218 | 19 | 0,0230 |
| | | Pw | L | $Y = 26,6557\ X^{0,8887}$ | 0,984 | 0,968 | 572 | 19 | 0,0333 |

Ch = total length of chela
F = length of finger of chela
C = carapace width
W = weight
L = total length

Pl = length of premaxilla
Pw = width of premaxilla
Ob = outer (upper) beak
Ib = inner (lower) beak

APPENDIX 2

INFORMATION ON TICKS COLLECTED FROM AONYX CAPENSIS OBTAINED FROM MISS J B WALKER, VETERINARY RESEARCH INSTITUTE, ONDERSTEPOORT

With one exception, all ticks have been provisionally identified as *Ixodes oldi.* This species has been recorded throughout Africa, including the Western and Eastern Cape Province. The ticks collected from *Aonyx* were apparently identical to those collected from the Cape grey mongoose from a number of localities in the Western Cape, but slight morphological differences between these and those collected further north exist. These differences led Dr C M Clifford, of the Rocky Mountain Laboratory, U.S.A., to identify the Cape specimens as *Ixodes oldi* (?). Miss Walker, however, regards these differences to slight to justify the classification of the Cape specimens as a new species.

*I. oldi* is predominantly a parasite of carnivores, although it has also been recorded from two species of *Cercopithecus* and from various rodents.

A total of 60 females, 7 males and 10 nymphae were collected mainly from around the ears of four individual otters.

One female *Ixodes pilosus* was also collected.