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Cephalopods in the diet of fur seals of the Galapagos Islands

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(With 1 figure in the text)

Vomit from seven Galapagos fur seals (*Arctocephalus galapagoensis* Heller, 1904) examined at Cabo Hammond, Fernandina Island contained 459 cephalopod beaks. Of these the 275 lower beaks were identified and measured. *Onychoteuthis banksi* (Leech, 1917) comprised 96·4%, ommastrephid species 1·8% and two other species 1·1%. Estimates from beak lengths show that *Onychoteuthis* comprised 74%, ommastrephids 25% and other species 1% of the weight of squids represented by lower beaks.

Contents

Introduction

There have been few studies of cephalopod remains from stomachs of predators in the neighbourhood of the Galapagos Islands. The most notable are the analyses of cephalopod beaks from tuna and porpoises to the west of Central America (Perrin *et al.* 1973) and from albatrosses examined in the islands (Harris, 1973).

The present collection of cephalopod remains vomited by adult Galapagos fur seals at Cabo Hammond, Fernandina Island provide an interesting addition to our knowledge of the cephalopod fauna of the region and a useful comparison with the collection from the other predators examined.

Material and methods

Vomit was collected from seven adult Galapagos fur seals and consisted of squid remains (Table I), nematodes and fish remains. One adult female seal (No. 7) vomited two damaged but almost complete squids, five heads, four bodies, three buccal masses and several beaks. The only cephalopod remains identifiable from the six other samples were chitinous beaks.

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TABLE I

Beaks collected from vomit of Galapagos fur seals

Sample No.	Date Collected	Sex of Seal	No. of upper beaks	No. of lower beaks of Ommastrephidae	No. of lower beaks of *Onychoteuthis*	No. of lower beaks of Others
1	21/12/77	Female	31	–	58	–
2	17/12/76	Female	33	–	34	–
3	24/12/76	–	5	5	3	–
4	12/12/76	–	28	–	53	1
5	23/12/76	–	2	–	–	2
6	12/12/76	Female	73	–	108	–
7	2/10/77	Female	12*	2*	9*	–
			184	7	265	3

The water temperature close inshore varied in Cabo Hammond between 16 and 23°C during the period of collection which was in December 1976 and mid-August to mid-November 1977. Only one sample (No. 7) was found in the August to November stay, the other six being collected in December. Most of the adult seals feed during the night and all the samples collected were vomited in the morning after return from the sea.

Upper beaks were counted while lower beaks were sorted into species and the lower rostral lengths were measured (L.R.L., Clarke, 1962) by means of an eye-piece micrometer and a Wild stereomicroscope. Weights of the squids represented were then estimated from the L.R.L.s using graphs published elsewhere (Clarke, 1962; in press).

Results

The samples included 184 upper beaks and 275 lower beaks including beaks removed from squids vomited by fur seal No. 7.

Family Onychoteuthidae

Two hundred and sixty-five lower beaks comprising 96.4% of all lower beaks were identified as *Onychoteuthis*. This identification can be safely narrowed to *O. banksi* (Leech, 1817) on the basis of comparison with the complete specimen, four heads and three bodies from sample No. 7. These specimens have 21 tentacular hooks and internal photophores resembling *O. banksi*; both features distinguish them from *O. borealijaponicus* (see Young, 1972). These beaks, however, are slightly different from one removed from a specimen of *O. banksi* caught in a net in the North Atlantic and this indicates a regional difference which is not obvious in other taxonomic features of the squids. The L.R.L.s have the frequency distribution shown in Fig. 1 with a model value of 0·18–0·2 cm. The wings of the smallest lower beaks are transparent but they develop an isolated brown patch at 0·14 cm which becomes joined to the dark region of the hood before the beak reaches a L.R.L. of 0·17 cm. The size of beak having this isolated patch is often characteristic of a species, particularly in a restricted geographical region (Clarke, 1962). From the relationships of L.R.L. to squid weight in this family the total weight represented by beaks in each size group can be estimated and summed to give the total weight of squid represented as approximately 3·0 kg. The mean weight of squids of this species represented by lower beaks is estimated as 12 g.

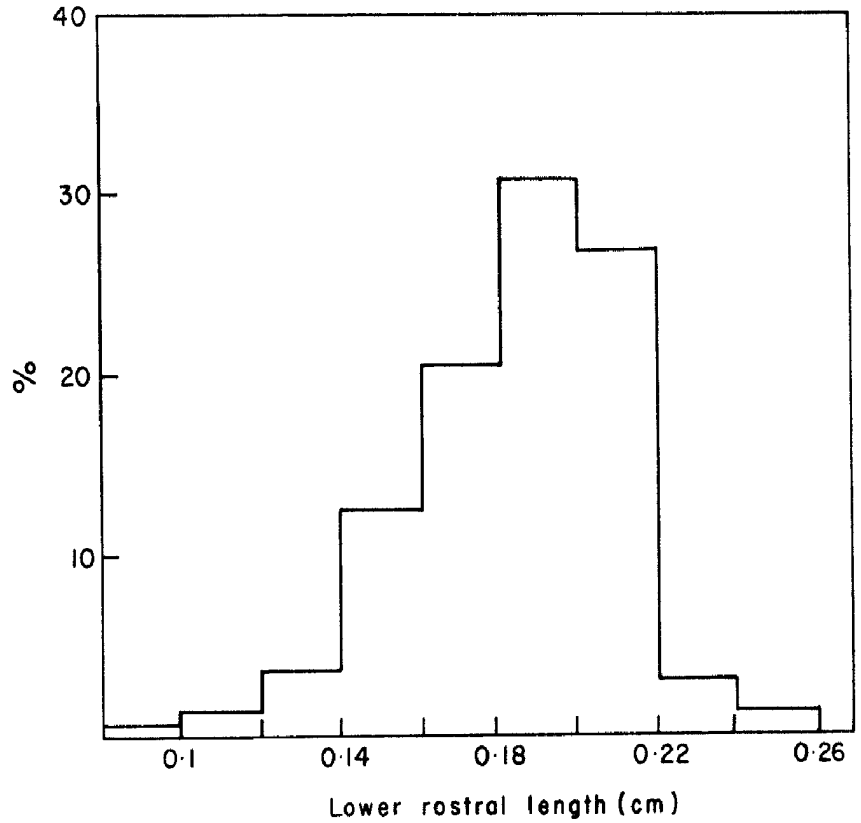

FIG. 1. *Onychoteuthis banksi.* Frequency histogram (%) of the lower rostral lengths of 256 lower beaks vomited by seven Galapagos fur seals on Fernandino Island.

Family Ommastrephidae

This family is represented by six intact and one damaged lower beak. In sample No. 3 three beaks had L.R.L.s of 0·48, 0·51 and 0·59 cm. Cartilage to the sides of the jaw angles shows that these beaks are from more "immature" squids and are therefore a different species from two beaks with darker wings and no cartilage having L.R.L.s of 0·38 cm. The isolated lower beak and the lower beak from the whole squid in sample No. 7 had L.R.L.s of 0·23 and 0·25 cm respectively and transparent wings. These beaks could belong to either of the two species represented by the larger beaks. Damage prevents a positive identification of the specimen but it is probably *Symplectoteuthis oualaniensis* Lesson (1830). This specimen has no "lemon" patch of light organs in the dorsal mantle as described for some squids currently included under this name (Clarke, 1965). The other ommastrephid represented by beaks is likely to be *Ommastrephes bartrami* (Lesueur, 1821) since their stage of darkening is too far advanced for their size for them to be the third ommastrephid common in the region, *Dosidicus gigas.*

The lower beaks of this family represent squids with estimated weights of 23–370 g totalling 1070 g and averaging 150 g (Clarke, 1962).

Other species

Three beaks could not be positively identified. One lower beak from sample 4 and another from sample 5 are very probably *Mastigoteuthis* and have L.R.L.s of 0·12 and

0·31 cm representing squids with weights of 2 and 31 g respectively. A small beak from sample 5 with a L.R.L. of 0·12 cm and dark wings could not be identified. From curve X (Clarke, 1962) this was probably from a squid of about 5 g.

Weight of squids

The total weight of squid flesh represented by beaks is estimated from the lower rostral lengths as 4156 g. *Onychoteuthis banksi* contributed 73%, ommastrephids contributed 26% and other species contributed 1%.

Discussion

Young (1972) redescribed *Onychoteuthis borealijaponicus* Okada, 1927 from Californian waters and gave several differences between that species and *O. banksi* (Leech, 1817) from Florida waters. He suggested *O. borealijaponicus* replaces *O. banksi* in the colder waters of the North Pacific since he notes the occurrence of *O. banksi* at 16°N, 123°W and Hawaii. The present collection of *O. banksi* from near the Equator is therefore of interest.

The predominance of onychoteuthids and the few ommastrephids in this collection can be compared with a large proportion of ommastrephids in tuna and both ommastrephids and onychoteuthids in porpoises (Perrin *et al.*, 1973) while octopoteuthids and histioteuthids predominate in albatrosses (Harris, 1973).

Although ommastrephids and onychoteuthids occur near to the sea surface, the octopoteuthids and histioteuthids are mainly much deeper-living squids and their occurrence in birds' stomachs needs some explanation. Clarke (1977) suggested theirp resence in birds might arise from their being brought near the sea surface in water upwelling near to the islands. However the exposed West coast of Fernandina is one of the areas of strongest upwelling and if this hypothesis were correct one would expect to find deep-living forms in fur seal vomit as well. This occurrence of deep-living species of squids is also seen in Wandering albratrosses studied at South Georgia (Clarke *et al.*, in preparation) and in that case there seems good reason to accept that the albatrosses are probably supplementing their diet of near surface squid by eating the vomit of sperm whales. Perhaps the fact that the fur seals are mainly eating near-surface forms, which is to be expected from what we know about diving behaviour of Northern fur seals (*Callorhinus ursinus*) (Kooyman *et al.*, 1976), suggests that the albatrosses of the Galapagos are not catching squids which are actively upwelled but are, instead, eating vomit of sperm whales.

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