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Algae on Jackass Penguins (*Spheniscus demersus*)

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Algae have been recorded growing on a number of aquatic animal species (Round 1981: 238). Boersma (1975) noted that algae occurred on the ventral surfaces of some Galapagos Penguins (*Spheniscus mendiculus*) but did not identify the algae concerned.

During a 7-yr study of Jackass Penguins (*Spheniscus demersus*) at St. Croix Island (33°48'S, 25°46'E) off the southeast coast of South Africa, we noted the occasional occurrence of algae on penguins. The algae were visible even from a distance but were observed only on penguins less than 3 yr old and predominantly on those in juvenal plumage. During 1982 and 1983 we made regular counts to establish the proportion of juveniles affected by algae (Table 1). A marked seasonal occurrence of the algae on juvenile penguins did not entirely coincide with the seasonal variation in juvenile numbers. Peak numbers of individuals with algae occurred during September, when the numbers of juveniles at the island begin annually to swell rapidly. At that time the juveniles return for a few days before departing for the premolt fattening period; they return about 6-8 weeks later to molt into adult plumage. Algae were not observed on molting penguins.

Whenever possible, we caught penguins with algae, recorded the extent of the areas covered with algae, obtained algal samples, and banded the penguin before release. The samples were obtained by wetting the affected area and then scraping off a sample with a scalpel blade. Part of the sample was placed in seawater, and the remainder was preserved in 10% formalin in seawater. Identification was later confirmed under a light microscope. The samples in seawater were examined as soon as possible after collection to note the degree of bleaching. A few feathertips were also removed to check for damage and points of algal attachment. The dominant algae in samples could be identified only to the generic level. Of the 26 penguins from which samples were obtained at St. Croix Island, 15 had *Enteromorpha*, 10 had *Ectocarpus*, and one had *Enteromorpha* and *Ectocarpus* in separate areas. In addition, one filament of *Porphyra capensis* was found in a sample of *Enteromorpha*, and diatoms were found in five of the *Ectocarpus* samples. Diatom growth, as described by Croll and Holmes (1982) on Common Murres (*Uria aalge*), was not observed. Fresh, unbleached, moist samples of *Ectocarpus* and *Enteromorpha* contained numerous protozoa. We have also noted algae on Jackass Penguins at other islands. For instance, on a visit to Dyer Island (34° 41'S, 19°25'E) on 29 October 1982, 0.4% ($n = 708$) of juveniles had algae. *Enteromorpha* was the only alga represented in the three samples obtained.

Visible algae were present only on the dorsal surfaces of the penguins (Fig. 1) and covered areas of up to 200 cm^2. (Bright green patches on the ventral surfaces were due to fecal matter.) Apparently the midback area became colonized only when growth had proceeded from the upper back and when moisture retention had been sufficient to allow colonization. The greater maximum length attained by *Enteromorpha* (10 mm), as compared with *Ectocarpus* (3 mm), when growing on penguins and possibly a greater dessication tolerance, as reflected in its higher position in the intertidal zone, might account for the more widespread occurrence of *Enteromorpha* on the penguin body.

Areas of worn plumage on subadult Jackass Penguins, particularly juveniles, often occurred in positions similar to those where algae grew. Typically, algae were attached to the rachis of feathers and often caused the tip of the rachis to curl upward. In Jackass Penguins with worn plumage and in those with algae, both barbs and barbules were frequently miss-

TABLE 1. Monthly trends in the presence of algae visible on juvenile Jackass Penguins (NS = not sampled).

	1982			1983		
	Juveniles present	Juveniles checked for algae	Juveniles with algae	Juveniles present	Juveniles checked for algae	Juveniles with algae
January	23	13	0	NS	NS	NS
February	5	2	0	51	19	0
March	5	3	0	NS	0	0
April	11	6	0	187	10	0
May	3	1	0	131	26	0
June	8	6	0	13	6	0
July	19	18	1	21	18	0
August	44	40	0	NS	NS	NS
September	515	387	17	2,136	393	6
October	3,028	320	2	1,660	244	3
November	785	200	0	2,138	133	0
December	2,766	200	0	3,332	200	0

ing at the distal end of the rachis. We believe that algae contributed to the feather damage.

It is notable that so few young Jackass Penguins have algal growth, considering that algae can grow rapidly and that these penguins are absent for long periods. Jackass Penguins less than 3 yr old spend months and often a year or more away from St. Croix Island, and presumably most of this time is spent at sea. St. Croix Island penguins are occasionally seen on other islands (Randall 1983), and it is possible that these short periods ashore serve to kill algae. For instance, on 25 September 1983, we banded a juvenile penguin that had an extensive growth of *Enteromorpha* covering most of the back and tail. It then left for sea and was resighted at the island on 15 January 1984. There was no sign of algae on the feathers, but wear patches were clearly visible. It is possible that the Jackass Penguins with algal infestations are those that have spent the longest unbroken spells at sea.

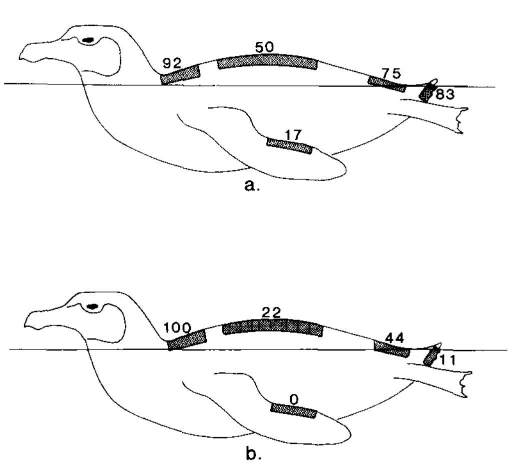

Fig. 1 Distribution of algae on Jackass Penguins represented as the occurrence (%) on different areas of the body. a. *Enteromorpha* ($n = 12$); b. *Ectocarpus* ($n = 9$).

Many of the algal samples taken from Jackass Penguins were bleached to varying degrees. We were able to show experimentally that exposure to sunlight on a black surface caused *Enteromorpha* to start bleaching after 1.5 days. Samples grown on asbestos tubing submerged in seawater reached a length of 4 cm in 1 month. After drying in sunlight for 3 days and then being resubmerged, there was total filament die-off, and recolonization of the tubing had to take place.

On one occasion, we noted that a Jackass Penguin with an extensive area of *Enteromorpha* had been actively preening the area, as evidenced by the algal filaments in its beak. Thus, Jackass Penguins may be able to rid themselves of algae, both actively, by preening, and passively, by visiting islands. It is probably important that they do so. Algal growth may affect waterproofing, as well as streamlining, particularly during diving. Both *Enteromorpha* and *Ectocarpus* are common ship fouling agents (Baker and Evans 1973).

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Further Insights into Nest-site Competition between Adelie and Chinstrap Penguins

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Trivelpiece and Volkman (1979) described male Chinstrap Penguins (*Pygoscelis antarctica*) usurping nest sites of incubating male Adelie Penguins (*P. adeliae*) at Point Thomas, King George Island, Antarctica (62°10'S, 58°39'W). Male Adelie Penguins arrived at the rookery in early to mid-October, established nesting territories, courted females, and took the first incubation shift while females fed at sea. Male Chinstrap Penguins arrived at the rookery in early November, shortly after the peak of Adelie egg laying. They displaced incubating male Adelies in all observed contests, courted female Chinstraps, and bred in the acquired nest sites.

We suggested that Chinstraps were able to displace Adelies partially because of the asynchrony of the breeding cycles of the two species; male Chinstraps, arriving fresh from the sea, competed with incubating Adelie males that had been fasting for 3 weeks. We did not understand however, why actual possession of a nesting territory by the Adelie Penguin did not outweigh, in defensive terms, its loss of condition from fasting. In addition, we were perplexed by this phenomenon because it contradicted the generally held concepts that "established" Adelie Penguins are very faithful to nest sites of previous seasons, and that young Adelies "home in" on their eventual breeding territory during their prebreeding years, an important activity in the establishment process (see Ainley et al. 1983). Therefore, we continued our examination of this phenomenon during the austral summers of 1981-1982 and 1982-1983 to quantify other factors, such as differences in age, breeding experience, and body weight, that might explain the male Chinstrap's superiority in these encounters.

Earlier studies of Adelie Penguins have shown that older, experienced breeders arrive and establish nesting territories earlier than do younger, inexperienced, first-time breeders and that older penguins have greater breeding success and are more nest-site tenacious (LeResche and Sladen 1970, Sladen and LeResche 1970, Ainley et al. 1983). Not having the opportunity to study known-aged birds, we used these criteria for aging our males and compared Adelies and Chinstraps involved in these agonistic interactions with banded males that had had previous breeding experience outside the areas of conflict.

We banded Adelie and Chinstrap pairs upon their arrival in 1981 and determined their 1982 arrival dates and nest-site tenacity. To quantify differences in body weights between the males of each species at the time of the conflict, we weighed a separate sample of Adelie and Chinstrap males. These penguins, all previously banded, experienced breeders of known sex, were weighed at 3-day intervals beginning on day 3. We calculated arrival weights by regressing the 3-, 6-, 9-, and 12-day weights back to day 0 and thus eliminated the weight of the stomach contents from arrival weights. Finally, we noted the activities of Adelies that lost nests to Chinstraps during their reoccupation period in 1981. At this time (mid-December to mid-January), failed breeders return to reoccupy their nest sites, and younger penguins arrive for their first visit to the rookery (Sladen 1958, Ainley et al. 1983).

The mean arrival dates of male Adelies occupying uncontested nest sites (11 October 1981 and 8 October 1982) were significantly earlier than the mean arrival dates of male Adelies occupying nest sites later claimed by Chinstraps (19 October 1981 and 17 October 1982, Table 1).

Chinstrap males occupying contested nest sites had a mean arrival date of 8 November in both years (n = 92 males), not significantly different from the mean arrival dates of the male Chinstrap population (10 November 1981, n = 64 and 8 November 1982, n = 42).

The 1982 arrival weights (mean ± SE) of 16 Adelie and 18 Chinstrap males did not differ statistically, although the Adelie males were heavier upon arrival (5.2 ± 0.1 kg and 5.0 ± 0.1 kg, respectively; $t = 1.86$, df = 32, $0.05 < P < 0.1$). By the time the Chinstrap males arrived, however, fasting Adelie males weighed only 4.2 ± 0.1 kg, significantly lower than the 5.0 kg Chinstrap arrival weight ($t = 6.32$, df = 32, $P < 0.01$).

In 1981, we banded 41 newly arrived Adelie pairs in a mixed colony where Chinstraps were later ex-