ECOLOGY AND BEHAVIOUR OF THE SOUTH GEORGIA PINTAIL *ANAS G. GEORGICA*

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Although several ducks live on isolated islands, the South Georgia Pintail *Anas g. georgica* is the only endemic form with a well-established, resident population within the Antartic Convergence. Commonly called a 'teal', its pintail relationships were pointed out by Murphy (1916); earlier workers had assumed that it was identical with the Kerguelen Island Pintail *Anas eatoni* (= *Anas acuta eatoni*) and used that specific name (Cabanis 1888, von der Steinen 1890, Szielasko 1907). It is now considered conspecific with the Brown Pintail *Anas georgica spinicauda* of South America and the Falkland Islands (Delacour & Mayr 1945). Of the two races, *A. g. georgica* is smaller in body size and has reduced extremities, which give it a stocky appearance (Delacour 1956). It is darker brown with a less brilliant wing speculum, but bill and leg colour of the two races are similar.

Several expedition naturalists made observations on the South Georgia Pintail, but left much about its biology and ecology unknown. Data now reported are part of a study designed to supplement our understanding of the evolution, adaptations, and current status of little-known subantarctic waterfowl. This study was conducted during November—December 1971 with the specific objectives of determining (1) distribution and population status, (2) habitat selection and adaptability, (3) principal diet of these ducks during the breeding period and (4) reproductive behaviour.

STUDY AREA AND AVIFAUNA

South Georgia and associated islands lie within the Antarctic Convergence of the South Atlantic Ocean at 53–55 °S, 35–38 °W. The main island, 160 km by 30 km, has a rugged and abrupt topography rising to 2950 m (Greene 1964). Glaciers cover more than two-thirds of the island, and the shoreline is indented with numerous fjords (Fig. 1). Only the lowlands along the sea are vegetated; tussock grass *Poa flabellata* is dominant among *c.* 24 native vascular plants (Greene 1964).

Observations were made at several large harbours along the north shore and at Bird Island and Cooper Island (Fig. 1). Intensive investigations were made at the ponds and streams of the two lateral moraines of Moraine Fjord, Zenker Ridge and Dartmouth Point in East Cumberland Bay (Fig. 2).

Climatic regimes have been reported for King Edward Point (Grytviken) on the main island by Mansfield & Glassey (1957) and by Richards & Tickell (1968), who also recorded data for Bird Island. Recorded mean air temperatures for these two stations varied from −2 °C in August to +7 °C in February; extremes of −11 °C and +21 °C were recorded on the main island. As a result of the moderating influence of the sea, there is no pack ice or freezing of saline water in winter, but freshwater ponds and fjords freeze; heavy snow is common at sea level, but is not long-lasting. There is no evidence that resident ducks migrate, and they are, therefore, restricted to the seashore during winter (Lönnberg 1906).

There are 26 species of birds known to breed on South Georgia. With the recent addition of Speckled Teal *Anas flavirostris* to the island avifauna (Weller & Howard 1972), there are four terrestrial or freshwater species: the South Georgia Pipit *Anthus antarctica*,

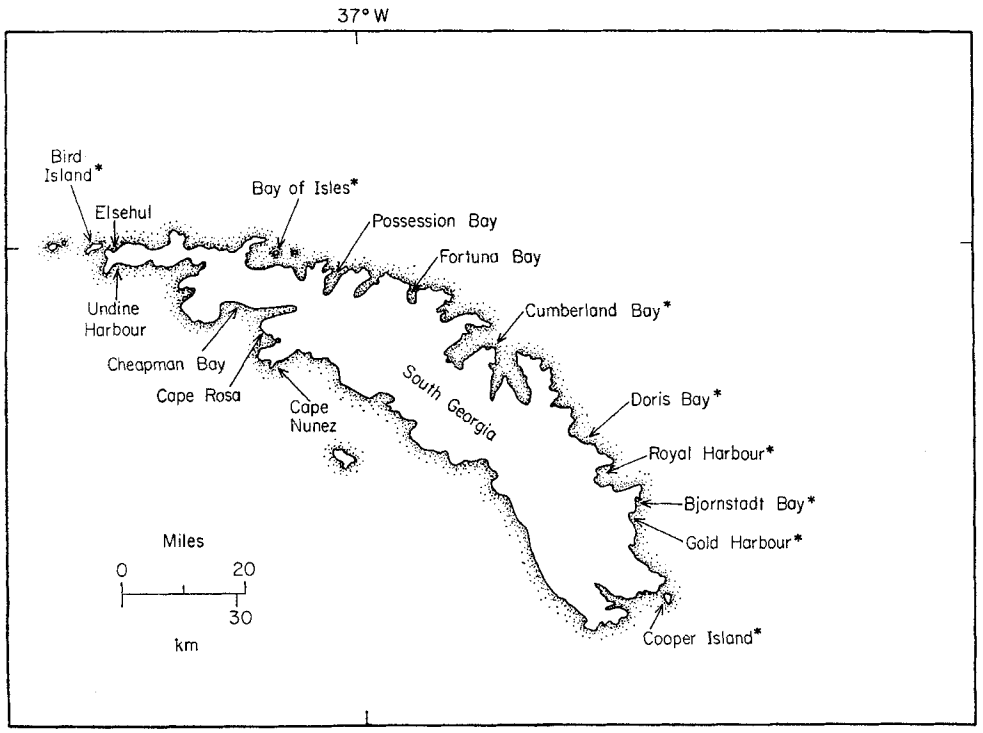

FIGURE 1. Map of South Georgia. Landing sites with an asterisk denote areas checked during this study.

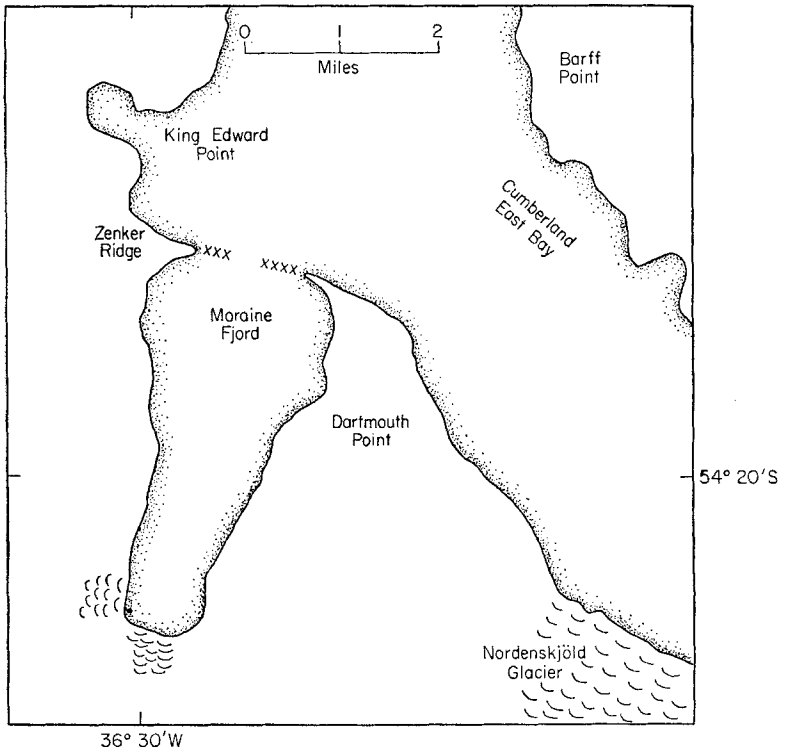

FIGURE 2. Location of study areas along Moraine Fjord, East Cumberland Bay, South Georgia.

which still is abundant on offshore islands where Brown Rats *Ratus norvegicus* are absent; the American Sheathbill *Chionis alba*, which is common in penguin colonies; and the two ducks. The remaining breeding birds feed at sea and are predominantly albatrosses, petrels, penguins and gulls (Stonehouse 1964).

The nearest islands inhabited by other waterfowl are the Falkland Islands, which lie *c.* 800 miles (1290 km) west and which support a diverse waterfowl fauna (Weller 1972) and several terrestrial passerines, including the Correndera Pipit *Anthus correndera*. This archipelago must be the source of the pipit, pintail and teal which became established on South Georgia.

METHODS

Birds were counted nearly daily on the intensive study areas at Moraine Fjord, and once on each landing elsewhere. To indicate habitat preferences, counts were summed according to the type of habitat frequented. At Moraine Fjord, it was assumed that birds would choose each day from the variety of wetlands available, and that such choice implied preference. Repeat counts on successive days were therefore treated as independent events, and separately added into the totals for each habitat.

Some time was devoted to describing the physiographic and limnological characteristics of wetlands in relation to use by pintails. Ponds on intensive study areas were sampled for aquatic invertebrates, pH, water clarity, depth, bottom profile, and surrounding vegetation.

Pair status, broods, sex ratio, and courtship behaviour patterns were noted. Much of the behaviour was recorded on 35-mm still and 8-mm ciné film, and calls were recorded by use of a parabolic reflector and tape recorder.

Feeding behaviour was observed intensively, even when birds could not be collected, and feeding substrates subsequently examined for evidence of food use. The five pintails collected were observed for 12–25 min before collection, and four were taken at different sites feeding in different ways. After collection, feeding sites were sampled with an aquatic dipnet 3 in. high by 12 in. wide (7·6 × 30·5 cm), involving a bottom sweep of 12 × 12 in. (30·5 × 30·5 cm) for benthos, and three 3-ft (91·5 cm) sweeps for swimming organisms. Hand grabs or scrapings were made where use of the net was impractical, for instance between boulders, rock surfaces, or in turf.

DISTRIBUTION AND STATUS

The South Georgia Pintail was first observed and collected by naturalists who accompanied Cook in 1775, and subsequently described by Gmelin (1789: 516). The German International Polar-Year Expedition of 1882–83 (von der Steinen 1890) and the Swedish collector Eric Sorling (April 1904—June 1905) reported 'teal' common, even congregating in flocks of 100 or more in winter along the shores of fjords (Lönnberg 1905, 1906). After the establishment of the Grytviken whaling station in 1904 and of other stations subsequently, Murphy (1916) implied that heavy shooting had reduced numbers considerably, and he rarely saw more than two dozen birds at one time. Murphy was on South Georgia during the austral summer (November 1912—March 1913) when ice-free conditions would permit a wider distribution of pintails and when breeding behaviour also would cause dispersion. He reported the bird widespread on the northern part of the island (which is less steep than the south) and suggested that it did not occur on the south side of the island. Wilkins (1923) saw only 20, but could not determine its status on the island as a whole. Carcelles (1931) reported a kill of 30 birds for food at Grytviken during October 1929. Holgersen (1945) cited a 1929 report that the bird was fairly common.

TABLE 1

Sites where South Georgia Pintail have been seen or collected

Location	Date	Record
Bird Island	1960–64	L. Tickell (*in litt.*)
	11–12 Nov. 1971	M. W. Weller
South Georgia		
North Shore		
Elsehul (Elsa's Harbour)	?, 22 Dec. 1921	Rankin 1951, Brit. Mus. (Nat. Hist.)
Bay of Isles	31 Dec. 1921	Brit. Mus. (Nat. Hist.)
Rosita Harbour	1929, 13 Nov. 1971	Carcelles 1931, M. W. Weller
Albatross Islet	13 Nov. 1971	M. W. Weller
Salisbury Plain	29 Dec. 1912, 13 Nov. 1971	Murphy 1916, M. W. Weller
Possession Bay	1775, Feb. 1913	Cook, Murphy 1916
Fortuna Bay	23 Nov. 1913	Brit. Mus. (Nat. Hist.)
Bay N. of Cumberland	?	Szielasko 1907
Cumberland Bay		
Jason Harbour	13 Dec. 1904	Lönnberg 1906
Maiviken	21 Nov. 1971	M. W. Weller
Grytviken-Moraine Fjord	1904–5,	Lönnberg 1906, Murphy 1916, Carcelles 1931
	28 Nov. 1912,	M. W. Weller
	1929, Nov.-Dec. 1971	
Sandebugten	Dec. 1971-Jan. 1972	P. Stone (pers. comm.)
Ocean Harbour	Mar. 1971	P. Stone (pers. comm.)
Doris Bay	17 Dec. 1971	M. W. Weller
Royal Bay		
Molke Harbour	Nov. 1882-Mar. 1883,	von der Steinen 1890
	16 Dec. 1971	M. W. Weller
Will Point	17 Dec. 1971	J. Tallowin (pers. comm.)
Bjornstadt Bay	18 Dec. 1971	M. W. Weller
Gold Harbour	19 Dec. 1971	M. W. Weller
South Shore		
Undine Harbour	27 Dec. 1970	J. Tallowin (pers. comm.)
Cheapman Bay	4 Jan 1971	J. Tallowin (pers. comm.)
Cape Rosa	29 Dec. 1970	J. Tallowin (pers. comm.)
Cape Nunez	30 Dec. 1970	J. Tallowin (pers. comm.)
Cooper Island	20 Dec. 1971	M. W. Weller

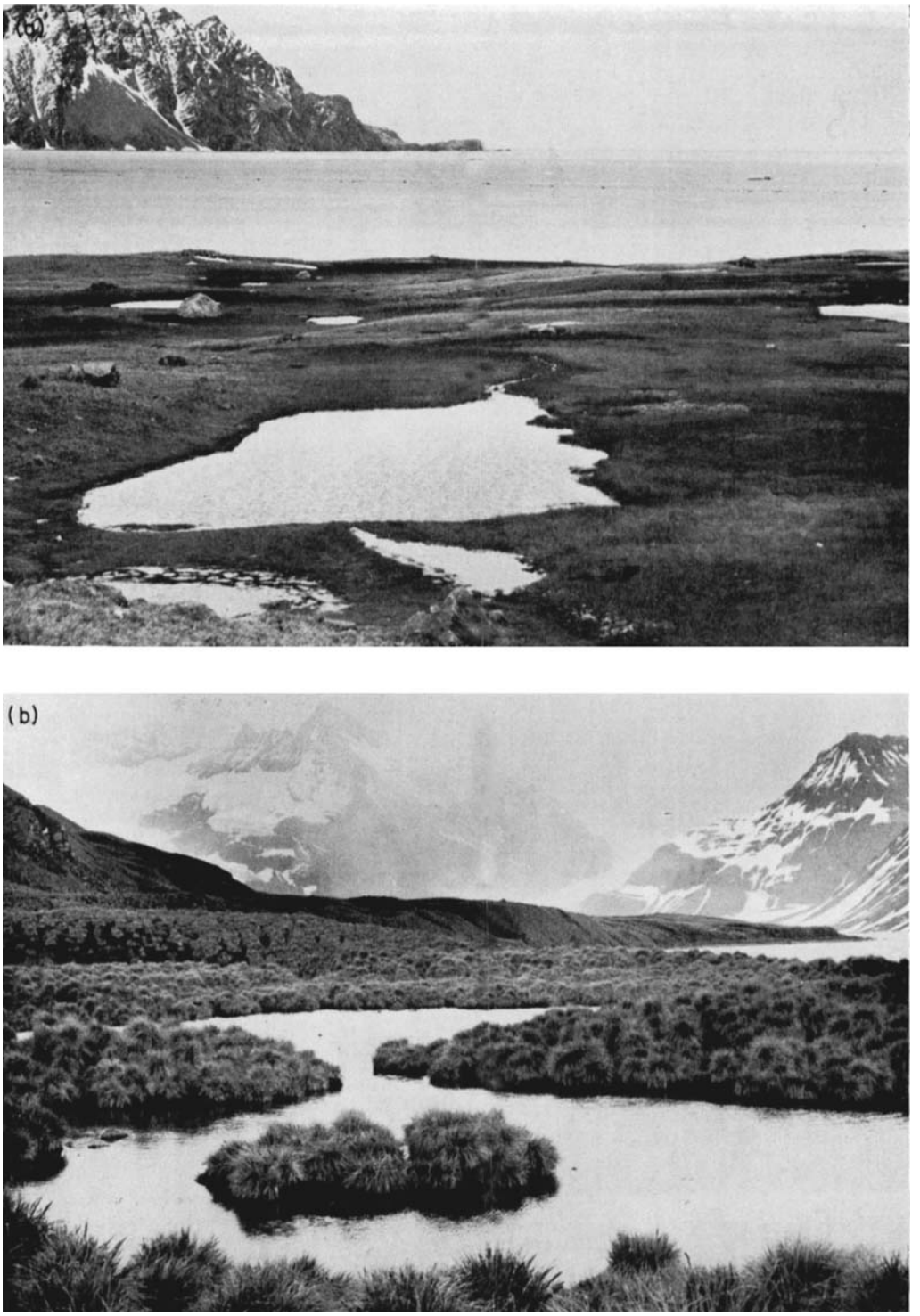

PLATE 17(a) Shallow ponds of low productivity in sedge mat areas at Dartmouth Point. King Edward Point is in the background. (b) Tussock-rimmed pond on the north end of Dartmouth Point. This more mature type of pond is rich in aquatic invertebrates.

In 1971, pintails were observed at landings listed in Table 1 and shown in Figure 1. Table 1 also includes records of other observers and from specimens in the British Museum (Natural History), providing further evidence of wide distribution on the north shore of South Georgia and on offshore islands to the northwest, north, and southeast. Pintails have been found on the western third of the southern side of the island, but the topography of the remainder of the southern coast is such that few could be expected.

Pintails clearly congregate in non-breeding periods and on occasions when food resources are locally abundant. Some were visible at every beach level enough for a boat landing. The species is evidently common and presently secure from direct harm by man because of its habits and habitat. Unlike South Georgia Pipits, it breeds in areas where rats are common, but the consequent impact on relative levels of production is unknown.

HABITAT

POTENTIAL WATERFOWL HABITATS

Although the interior highlands are steep and glacier-covered, there are numerous freshwater basins near the sea which at times support large numbers of a few species of invertebrates. Most ponds do not exceed 3 ft (0·91 m) in depth, but those on the east side of the Moraine Fjord near the Harker Glacier lie in a sloping moss-sedge meadow and are over 8 ft (2·4 m) deep. Still larger and deeper ponds occur on gravel outwash plains or plateaux near sea level or occasionally in foothills. Some of these lakes exceeded 15 ft (4·6 m) in depth; those examined near Maiviken had little surrounding vegetation and few invertebrates. Basins formed by the irregular deposition of debris during glacial recession are sterile and unattractive when recently formed (Plate 17a), but later may be very rich in invertebrate life when surrounded by tussock (Plate 17b). All freshwater is highly acid and cold (Table 2). Those ponds in peat soil of tussock grass were richer in number and diversity of invertebrate taxa (Table 3) and tended to have high turbidity. Fairy shrimp *Branchinecta gaini* were abundant.

TABLE 2

Some limnological characteristics of streams and ponds on South Georgia, November–December 1971

	pH		Temperature (°F)		Clarity (inches)	
	n	range (av.)	*n*	range (av.)	*n*	range
Streams	4	4·4–5·0 (4·7)	4	33–47 (40)	–	–
Ponds and lakes	14	4·1–4·9 (4·5)	14	39–65 (43)	5	3–8

Formation of wetlands occurs in several ways. The growth form of tussock grass is conducive to inter-tussock depressions, and meandering trickles of water form pools only a few feet in diameter attractive to single pintails and pairs seeking isolation. Larger and often linear pools and ponds tend to form by solifluxion, and slopes of 25–30 ° may have small ponds; larger ponds tend to be on slopes of 10–15°. In some instances, meadows remain where sedimentation has filled in former ponds. Barrier beach ponds are perhaps the most widespread type. Those formed at higher sea-levels and now surrounded by tussock tend to be rich and much used by pintails.

Pools of all sizes near the sea are enriched by droppings of Elephant Seals *Mirounga leonina* or by drainage from colonies of King Penguins *Aptenodytes patagonicus* or Gentoo Penguins *Pygoscelis papua*. Such ponds have heavy blooms of unicellular algae during the summer. Tussock-covered cliffs or steep slopes were used by nesting Black-browed

TABLE 3

Incidence of principal groups of freshwater pond invertebrates in benthos samples, South Georgia, November–December 1971

Pond type	No. ponds	No. taxa	Frequency of occurrence (per cent)							
			Fairy shrimp	Cyclops & Daphnia	Nematoda	Diptera	Dyticidae	Annelida	Arachinida	Collembola
Tussock-rimmed	10	8	66	66	50	30	30	30	30	30
Moss-sedge	9	5	0	77	44	11	66	11	0	0
Temporary tussock pools	4	5	0	0	25	25	0	50	25	25
Wet soil or turf	2	2	0	0	50	0	0	0	0	50

Albatrosses *Diomedea melanophris*, Gray-headed Albatrosses *D. chrysostoma*, Light-mantled Sooty Albatrosses *Phoebetria palpebrata* and White-chinned Petrels *Procellaria aequinoctialis*, and lower hillsides were used by Brown Skuas *Catharacta skua*, Giant Petrels *Macronectes giganteus* and Antarctic Prions *Pachyptilia desolata*. Nutrients, brought by these birds from the sea as food for young and expelled as wastes, must further enrich the tussock and the streams and ponds below.

Streams vary in size from seasonal trickles, resulting from the percolation of rain and snow-melt through boggy soil and vegetation, to steady-flow streams stemming from melt of glaciers and snowfields. These larger streams are clear, cold and sterile and, depending upon topography, may form lakes enroute to the sea. Fluviatile deposits may accumulate at stream mouths, and often provide the only safe places for boats to land.

Beach substrates vary from fine to coarse gravel in sheltered coves, to large boulders or rocky outcrops where there is considerable surf action. There are many cliffs.

HABITATS USED BY PINTAILS

The study area surrounding Moraine Fjord included extensive seashore, less saline fjord waters, streams of several sizes, barrier ponds, glacial moraine ponds, and wallows and pools of various sizes in tussock. Tussock-rimmed freshwater ponds were areas most favoured by pintails for feeding, resting, and courtship during early summer, and all broods were seen there (Table 4). Adults, however, flew to the seashore at low tide. In early November, pintails at Jordan Cove, Bird Island, regularly fed along the seashore, which was predominantly gravel and boulders. Such behaviour was rare in the Grytviken area in mid-November, but by late November, pintails were observed feeding and loafing on rocky outcrops. During late November and early December, they fed regularly in this habitat in Moraine Fjord near Dartmouth Point.

In addition to the freshwater ponds, pintails regularly fed in wet drainage or pools, often at some distance from ponds. Most pools were in tussock, but a few favoured areas were in sedges and grasses. Isolated pools of this type were used mostly by pairs or lone females, presumably to avoid sexual and social conflicts of large flocks on ponds.

Larger streams were used occasionally by loafing pintails during bad weather, but obviously were not favoured feeding areas. Hand grabs and benthos samples showed little in the way of food organisms in the gravel or rocks of streams. Small drainages from tussock areas and penguin colonies were used for feeding, presumably being richer in invertebrates.

TABLE 4

Use of wetlands by South Georgia Pintail and Speckled Teal. Total number of ducks observed in repeated counts on study areas and single counts at different landing sites, South Georgia, November–December 1971. *Percent of total shown in parentheses*

	No. pintail	No. pintail broods	No. Speckled Teal	No. Speckled Teal broods
Tussock-ponds	307 (59·7)	8 (100)	77 (96·3)	4 (100)
Seashore and Fjord	87 (16·9)	0	2 (2·5)	0
Pools and puddles	34 (6·6)	0	0	0
Seal wallows	25 (4·9)	0	0	0
Streams and drainages	17 (3·3)	0	0	0
Dry tussock	16 (3·1)	0	0	0
Sedge-ponds	15 (2·9)	0	1 (1.3)	0
Rock outcrops	10 (1·9)	0	0	0
Oxbow pond	3 (0·6)	0	0	0
Total	514	8	80	4

HABITAT-RELATED BEHAVIOURAL ADAPTATIONS

In spite of its usual feeding methods (below), the South Georgia Pintail is well adapted to terrestrial activities. It is common to encounter pintails resting in tussock some distance from water (Table 4). Several pairs were seen flying high up hillsides to land in dry areas, perhaps seeking isolation. Some nests may be situated in such places.

With the tameness typical of birds of islands where native terrestrial predators are lacking, the South Georgia Pintail may walk out of the water to meet an oncoming man—seemingly in curiosity. If undisturbed, the birds may walk along the seal trails in tussock grass, seeming now and then to observe. Once satisfied, they may return to water and feed a few feet away. One pintail, tracked in light snow, had visited several frozen seal wallows and finally broken through the ice in one, where it presumably fed.

Feeding along seashores or fjords was clearly tide-related (Table 5). Pintails left freshwater ponds to feed at sea only during calm weather or only in sheltered areas. They avoid wave action by facing oncoming waves and riding over them rather than allowing themselves to be washed. Pintails were seen resting or feeding on boulders or wave-washed outcrops both offshore and on the beach.

TABLE 5

Relationship between use of fjord shoreline by pintails and tide level, Dartmouth Point, East Cumberland Bay, South Georgia, 5–7 December 1971

Tide	Number of pintails observed	
	Fjord shoreline	Ponds
Low	10	—[1]
Low	10	—
Low	5	3
High	2	6
High	0	9–11

Note: [1] Ponds were not checked every day.

FEEDING BEHAVIOUR AND FOODS

Feeding was usually with head and neck underwater or upending both in ponds and at the seashore. Diving, however, was a regular activity in deeper ponds where fairy shrimp were abundant. Birds dived in the usual fashion of dabbling ducks—rather awkwardly and with partly open wings and spread tail. These ponds were only 18–30 in. deep but, presumably, diving made feeding easier. Average duration of 23 timed dives of adults was 8·1 s (range 6–11), and 10 diving intervals averaged 6·6 s (range 4–11). One downy young about 1 week old dived a few times, but fed mostly by surface dabbling.

Two males (1 and 2, Table 6) were collected while feeding in tussock-rimmed ponds, one on the Zenker Ridge and one at Dartmouth Point. One had fed for 25 min by upending and dabbling in 6–12 in of water; it had taken fairy shrimp. Another, which had fed by diving for nearly 15 min in 18–30 in of water, also had taken fairy shrimp. Although *Cyclops* and *Daphnia* were present in the water, and the birds collected were opened at the site to avoid post-mortem digestion of fragile food items, recognizable remains of these small crustaceans were not contained in the gut. It seems likely by their behaviour that the pintails were feeding only on the larger organisms near or on the bottom.

Pintails occasionally fed in the soggy soil of poorly drained situations, at the edge of pools or melting patches of snow, or along streams. Nematodes were common at such places, and in one case, grass seed *Phleum alpinum* also was abundant. Several pairs were

TABLE 6

Oesophagus and proventriculus contents (combined totals) of five South Georgia Pintails collected 25 November–4 December 1971 in East Cumberland Bay, South Georgia. Gizzards held the same taxa and proportions but contents were considerably more digested and difficult to quantify

		Site	Feeding method	Contents (cm^3)[1]
1	♂	Tussock-pond	Upending	Fairy shrimp (0·7), veg., feathers, sand (0·4)
2	♂	Tussock-pond	Diving	Fairy shrimp (9·8), veg., Diptera, sand (0.2).
4	♀	Grass-sedge	Rooting; dabbling	Vegetation (0.5), Nematoda, fil. green algae, sand.
5	♂	Fjord shore	Upending	Amphipods (6·5), snails with algae (5·3), clam, sea lettuce, br. algae, fil. green algae, sand (0·2).
6	♀	Fjord shore	Upending	Amphipoda (6·0), snails (3·5), clam (0·2), plant.

Note: [1] Material present only as a trace is identified without an estimate of volume.

seen rooting at the waterline in seal wallows or ponds, and others grabbed at overhanging grasses. Some fed on the water's surface on floating green algae and arthropods caught in the surface tension of the water. Invertebrates found in this situation were springtails (*Collembola*), mites (Arachnida) and midges (Diptera).

From the evidence of an obvious brood patch but enlarging ova, a lone female (No. 4 in Table 6) between nesting efforts fed at the edge and in shallows of a clear pool among sedges, moss, and Greater Burnet *Acaena adscendens*. Samples at this site yielded filamentous algae, nematodes, and some *Cyclops* sp.; the female had eaten the first two items but not *Cyclops*.

At the seashore, pintails fed mostly on amphipods, snails, small clams, and algae as indicated by a pair of birds (5 and 6, Table 6) collected in Moraine Fjord. Several birds at the shore, especially on Bird Island, grabbed floating sea lettuce *Ulva* sp. and unidentified filamentous green algae. Pintails fed in *Porphyra* sp., presumably dabbling for invertebrates, but did eat fine green filamentous algae clinging tightly to supratidal wave-washed boulders. These observations on diet agree with the few previous reports: amphipods (Murphy 1916); small animals and algae of fjords (Lönnberg 1906); molluscs and crustaceans (Matthews 1929).

In summary, South Georgia Pintails during the pre- to early breeding season selected mostly large invertebrate foods, but pairs or single birds often fed on smaller prey in more isolated, but less rich wetlands. Plant food was a minor item in the diet at this season. This preference during the breeding season has been shown in Pintails *Anas a. acuta* to be essential for egg-production (Krapu 1972), and the usual idea that pintails eat seeds (Martin, Zim & Nelson 1951) is a product of samples taken mainly in the autumn. The long neck is clearly a mechanism for obtaining food in deep water, where they compete with few other ducks.

REPRODUCTION

CHRONOLOGY OF NESTING

Although records in the literature indicated initiation of breeding activities in late November and December, it was obvious from temperature regimes of the island that breeding could occur earlier. Field work started on 11 November 1971 when, although no nests were located, the incidence of pairs, chases, and female Repulsion gestures

indicated that nesting had started. Tracks of ducklings were observed in a light snow on 23 November, and a brood of two young, 5–7 days old, were seen on 24 November. Assuming that South Georgia Pintails and Pintails *Anas acuta* grow at a similar rate (6–7 weeks according to Hochbaum 1944), hatching probably occurred on 17–19 November. Because clutches of four to five eggs seem most common (Pagenstecher 1885, Murphy 1916), and assuming a laying rate of one egg per day and 22 days incubation (Hochbaum 1944 for pintail), nesting must have begun about 22 October. The condition of the gonads, weights and other features of the five collected birds demonstrated that they were in full breeding state in late November and early December (Table 7).

TABLE 7

Details of five South Georgia Pintails collected in East Cumberland Bay, South Georgia–25 November to 4 December 1971

		Date	Weight (g)	Gonads (mm)	Moult	Fat	Bursa
1	♂	25 November	625	L=21·5 × 8·1 R=20·8 × 7·8	Extensive	Yes	3mm wide 14mm deep
2	♂	30 November	610	L=37·9 × 18·2 R=35·2 = 18·1	No	No	None
5	♂	4 December	660	L=40 × 18 R=38 × 18	No	Very	None
4	♀	2 December	460	24 × 15 Ovum=9·4	Brood patch	Yes	None
6	♀	4 December	610	27 × 16 Ovum=7·9	No	Very	None

The latest direct record of reproduction is a juvenile mentioned by Lönnberg (1906) as taken in May. Although this specimen now is missing from the collection of the Naturhistoriska Riksmuseet of Stockholm, another bird taken in April and termed a juvenile is perhaps 4 weeks old. Available dates of eggs and downy young (Table 8) indicate that nesting can occur at any time from late October to the end of February. Evidence is inadequate to demonstrate a peak in nesting activities. Pagenstecher (1885) noted the long breeding and assumed that the pintails were double-brooded. This long period, however, probably is due to re-nesting. The generally harsh but equable climatic

TABLE 8

Information on chronology of reproduction of the South Georgia Pintail

Event	Date	Authority
First nest initiation	23 Oct. 1971 (calculated)	This study
First copulation	19 Nov. 1882	von der Steinen 1890
Nests and eggs found	7 Dec. 1904	Lönnberg 1906
	8 Dec. 1882	von der Steinen 1890
	28 Feb. 1913	Murphy 1916
First brood observed	24 Nov. 1971	This study
	13 Dec. 1904	Lönnberg 1906
	18 Dec. 1882	von der Steinen 1890
	6 Feb. 1913	Murphy 1916
Last flightless young with down	15 Mar. 1883	von der Steinen 1890
Post-breeding moult of hen	13 May 1902	Specimen in Stockholm Riksmuseet

conditions presumably do not favour selection for a more restricted season. That breeding does not occur year-round may be due to the need of ducklings for ice-free ponds, both for food and warmth. Koskimies & Lahti (1964) have discussed cold-hardiness in ducklings, and shown that water temperature must be considered as a limiting factor in timing and area of breeding.

No birds flightless because of wing moult have been reported, probably because failure of pintails to fly surprises no one, and possibly because birds are secretive at that time. Moreover, few field workers have collected or observed pintails in the austral autumn. In examination of museum specimens, only one female, collected in early May 1902, had soft outer primaries indicative of recent moult (Naturhistoriska Riksmuseet, Stockholm, Sorling 49).

COURTSHIP

Courtship displays were most common where a few to 25 birds collected on sheltered and often food-rich ponds. Pair bonds seemed well established, even in mid-November. The few lone females seen often repulsed males, and were accordingly thought to be incubating birds during rest periods. In 304 birds (including repeated counts) for which sex could be determined, the ratio was 2·5 males per female; other authors also reported an excess of males (Lönnberg 1906, Murphy 1916). Displays were mostly initiated by excess males when a pair swam or flew into a feeding, resting or courting flock. After a series of calls and displays, the pair either joined the flock with little further display, or left if intensive courtship and chases ensued.

The displays were so similar to those of the pintail that figures by Lorenz (1941), Johnsgard (1965) and Smith (1968) aptly describe the general pattern. Any differences which exists will only be shown by careful analysis. Chin-lifting was seen in both sexes when pairs were confronted by courting males. The chief vocalization and display, the Burp-whistle, usually involves a wheezy, hollow-sounding *geeeeegeeeee* (Lorenz 1941) with a shorter, but concurrent, whistled *twer-dip*, which sounds double-noted but which appears as three notes on sonograms. Both calls can be given independently. Comparison of this call with that of *A. g. spinicauda* made by captive birds in central Argentina suggests that components of the Burp-whistle are similar in duration and frequency, but the resonant background mew call is less complex in *A. g. spinicauda*, while a pumping sound preceding the whistle is more conspicuous in *A. g. georgica.*

The Grunt-whistle is much less common than the Burp-whistle and occurs only in intense courtship. My observations on *A. g. georgica* agree with Lorenz (1941), Johnsgard (1965) and others on *A. g. spinicauda* that the Head-up-tail-up display is either absent or rare. I did not see Turning-the-back-of-the-head but it may occur; Johnsgard (1965) reported it in *A. g. spinicauda.*

Females also engage in Chin-lifting and occasionally give the Inciting posture and call when a pair is approached by one or several excess males. Lone females and paired females commonly give the Repulsion gesture and associated rasping call when sexually active males approach. When pressed by oncoming males, the female may go onshore. If a male is present, he may walk with her, but he does not defend against the intruder. Once a female flew about 10 ft up to a tiny rock ledge where she gave the Repulsion call while the male that had been with her and a new male sat in the water. Drinking and preening were common by birds in such conflicts.

When several males continue to press a lone or paired female or attempt to rape her, she takes flight with the head-in Repulsion posture and call. Her male follows, but usually well behind the aggressor male. On some flights the birds rose hundreds of feet into the air, and flew off several miles. Other flights were short-lived, and the pair dropped into a pond unmolested. This behaviour is precisely that described for pintails by Smith (1967) and may function in dispersing nesting females as elaborated by McKinney (1965).

On several occasions, lone pintails rose to give chase to passing pairs and subsequently returned to their loafing or feeding site, as if in territorial defence.

The Head-down flight of broody pintail females was seen on two occasions. I did not see Nod-swimming, copulation or bridling.

BROOD REARING

Murphy (1916) reported five as the common number of young in a brood, but did not detail the numbers he saw. One brood of 3 was reported by von der Steinen (1890). I saw five broods, consisting of 1, 1, 2, 3, and 4 ducklings. South Georgia Pintail females were very wary, and broods were seen only by chance encounter or as a result of waiting by small, much-dissected areas of water early or late in the day. Although broods occasionally crossed stretches of open water 100–150 ft wide, the usual procedure was to feed around the edges, with the female in more open water and the young probing in the bank, grabbing at vegetation, and surface feeding. One young fed just behind or under the female's tail as she upended, taking advantage of organisms churned up by her paddling. Occasionally, downy young dived. Their colour is a much darker brown than young of the *A. g. spinicauda*, providing effective camouflage in the dark shadows of tussock in brownish water.

Of five broods seen, in only one was the female (with a single duckling) accompanied by a male. Probably the same duck and young were later seen again in the same area without a male. On one occasion, a sexually active male harassed this female and eventually accompanied her for a while in spite of her initial Repulsion gestures. Such behaviour by males may have induced females with broods to remain in small areas where protective cover was available.

Tracking of broods in the snow showed that broods move from pool to pool overland in the tussock. When alarmed, they are difficult to locate and even more difficult to catch (see Lönnberg 1906, Murphy 1916).

INTERSPECIFIC RELATIONSHIPS

Until recently, the South Georgia Pintail was the only bird feeding on the invertebrates of freshwater and mud flats. Now the Speckled Teal occurs in the same ponds (Table 5) and must also use the seashore in winter (Weller & Howard 1972). Most feeding by Speckled Teal was confined to ponds where they were probably taking crustaceans. The gut of one individual collected contained *Daphnia*, pieces of fairy shrimp, nematodes, *Cyclops* and fine plant material. These two species co-exist throughout much of Argentina (Weller 1968) and in the Falkland Islands, but their degree of overlap in foods has not been adequately measured. Visual observations suggest that the two exploit non-overlapping feeding zones; the long-necked pintail feeds in deep, more central waters, while the teal uses marginal areas of shallow water and especially mud flats where it strains out minute crustaceans (Weller 1972). Significant levels of hybridization would not be expected because wild hybrids are unknown (Johnsgard 1960).

Murphy (1916) reported that the Brown Skua is a predator on eggs, and retrieves adults killed by hunters. I saw skuas dive at adult pintails and frighten them but no one has reported the direct killing of an adult. Lönnberg (1906) inferred that skuas take ducklings but also noted that ducklings are wary and secretive.

Another observed interaction was purely accidental, but might be misinterpreted as predation. Young Elephant Seals often lie submerged in the ponds where ducks feed. They rest completely underwater at times, and when they raise their heads, may frighten ducks swimming or loafing on the surface. Once with adults and once with a brood, the birds scattered in alarm. Usually, however, the ducks are aware of their presence and move off slowly. On four occasions, young Elephant Seals were seen intentionally chasing

swimming ducks. Their interest and action was that of casual play rather than the intensity or direction of a predator, and the ducks avoided them by swimming but showed no great alarm.

DISCUSSION

ORIGIN AND ADAPTATIONS

The South Georgia Pintail clearly originated from the South American Brown Pintail and now is smaller, darker, and has reduced extremities (Lack 1970). The general colour of extremities of both races is similar. I noted several males on Cooper Island with a distinctive yellow-orange rather than yellow bill, but no birds from this area have been collected. Murphy (1916) stated that the South Georgia Pintail has 16 tail feathers whereas *A. g. spinicauda* has 14. However, there is variation in both forms.

Because the general colour, morphology, calls and courtship behaviour are so similar to the continental form, it is unlikely that the two forms have developed reproductive-isolating mechanisms that would prevent inter-breeding if they were sympatric. Moreover, because of the propensity of ducks toward hybridization in captivity, experimental studies may not be revealing.

Island ducks tend to be highly adaptable in their home area (Lack 1970). The South American Brown Pintail is a successful and widespread species, and its dispersal from South America to South Georgia presumably was eased by the stepping-stone provided by the Falkland Islands. Pintails are strong flyers, and the dominant westerly winds and the commonness of strong storm systems at that latitude would be conducive to transport from Tierra del Fuego or the Falkland Islands towards the east and south. *Anas g. spinicauda* has been collected at Deception Island in the South Shetlands (Bennett 1922) and observed at Signy Island in the South Orkneys (Burton 1967).

Success of the pioneering pintail stock was possible because of the presence of protected, relatively warm, and food-rich ponds where young could be reared. No broods have been reported in streams, fjords, or the seashore; the nesting habitat of *A. g. spinicauda* on the Falkland Islands is also a shallow pond with emergent vegetation rich in invertebrates (Weller 1972). Although the stress of the winter presumably prevents breeding, temperature extremes are not great, and food resources of the sea are plentiful. Marine filamentous algae may supplement the diet after the breeding season.

Populations of *A. g. spinicauda* in Tierra del Fuego and the Falkland Islands commonly feed in brackish estuaries or tidal areas during the non-breeding season. This habit in a predominantly freshwater species also pre-adapted the pintail stock for life on South Georgia.

CLUTCH-SIZE

No workers have reported clutches of South Georgia Pintails of more than 5 eggs whereas clutches of up to 10 eggs have been reported for *A. g. spinicauda.* As precocial birds, the ability of the adults to feed the young is not an important factor in evolution of size of clutch as it seems to be in passerines. The availability of high protein invertebrate foods for females during the crucial egg-laying stage could limit the number of eggs in the clutch (Krapu 1972). In addition, the protective brooding of young by the hen during cold nights and her protective behaviour in time of attack by predators may influence the number of young she can successfully rear. Murphy (1916) suggested that a clutch of about five was the maximum number that females could incubate under prevailing temperatures, but the severity of the weather is little, if any, greater than during nesting of pintails in April in North America where the clutch-size of early nests is nine eggs (Sowls 1955). Nevertheless, all these factors may play a role in the evolution of this clutch-size.

STATUS

Although it is impossible to estimate the population of the South Georgia Pintail precisely, there is little doubt that several thousand birds were present in 1971. There is probably little habitat not filled. The birds of South Georgia are currently protected by the policies of Great Britain governing the areas under the jurisdiction of the British Antarctic Survey. The bird is not now endangered, but unforeseen development in resources use on or around South Georgia could change this situation. All precautions must be taken to avoid the introduction of potential predators or competitors.

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SUMMARY

A study of the feeding ecology and breeding biology of the South Georgia Pintail was conducted in East Cumberland Bay during November and December 1971. Of a variety of water areas available, pintails fed and reared their broods in tussock-trimmed ponds. The second most important feeding areas were sheltered fjords and seashores. Food included freshwater invertebrates such as fairy shrimp, marine amphipods and snails, and small amounts of marine algae. Considering the climatic conditions, the breeding season spans a long season from late October to early March. Courtship and social behaviour are very similar to that of the pintail, and displays and calls could not be differentiated from those of *A. g. spinicauda*.

There is now one other species of duck on South Georgia, the Speckled Teal, but, because it occurs sympatrically with *A. g. spinicauda* throughout temperate South America and tends to use different food resources, no serious competition is expected.

It is concluded that these species have successfully adapted to South Georgia because of the availability of protected, food-rich ponds for rearing young and because of the semimarine adaptations that have developed in Tierra del Fuego and the Falkland Islands.

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