

## Analysis of the attempts to breed seabirds in uninhabited territories of the Haswell archipelago and Adams Island (East Antarctica)

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### Abstract

Data on new breeding sites of seabirds in Antarctica allow a better understanding of spatial species distribution, correct population estimates, and the processes occurring in populations and ecosystems. The aim of the work is to compile and analyze knowledge about the spatial distribution of breeding seabird populations and attempts to breed in new, previously uninhabited territories. Ground-based observations and population counts were conducted at the Haswell archipelago (Queen Mary Land, Davis Sea) by several observers from 1912 to 2016. The total area studied was 12 km<sup>2</sup>. An aerial census of penguins on Adams Island was conducted in 2011. Based on this census, it might be stated that 6 out of 9 breeding species of seabirds have made attempts to develop new breeding sites. Regular breeding of birds within the archipelago is established on 8 islands. Emperor Penguins (*Aptenodytes forsteri*), Snow Petrels (*Pagodroma nivea*) and South Polar Skuas (*Stercorarius maccormicki*) showed no change in spatial distribution. Adélie Penguins (*Pygoscelis adeliae*), Southern Fulmars (*Fulmarus glacialisoides*), Cape Petrels (*Daption capense*) and mixed pairs of Brown Skua (*Stercorarius antarcticus*) × South Polar Skua bred in new sites (6 islands and 1 nunatak). New likely breeding sites have been recorded for the Southern Fulmar, Cape Petrel and Wilson's Storm Petrel (*Oceanites oceanicus*). An unsuccessful breeding attempt in a previously uninhabited territory has been observed in the Antarctic Petrel (*Thalassoica antarctica*). New breeding sites for seabirds may result from the avoidance of predation by South Polar Skuas. Changes in local meteorological conditions could be a factor contributing to the breeding attempts by seabirds in the territories previously uninhabited by them. The increase in South Polar Skuas populations, invasion of Brown Skuas on the Haswell Islands, increased breeding attempts and occupation of new breeding sites by Adélie Penguins and tube-nosed seabirds in the early 21<sup>st</sup> century are evidence of changes in ecological conditions in the local ecosystem.

**Key words:** Mirny, new breeding sites, occupation, birds

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## Introduction

Knowledge of spatial distribution is important in ecological studies and crucial for conservation and management of species and biodiversity (Southwell and Emmerston 2013b). Newly discovered breeding sites of some seabird species allow to better understand their biogeography, to improve population estimates, to update the global population size (Barbraud et al. 1999, Lea and Soper 2005, Wilson 2009, Wilson et al. 2009, LaRue et al. 2015, Ancel et al. 2017, Gryz et al. 2019). From data reported by different observers, the causes of colonization by bird species of previously uninhabited territories and the processes occurring in populations and ecosystems might be identified and evaluated. Against this background, the identification of colonization events and breeding attempts of seabirds in new sites – in previously uninhabited territories, is possible only on the basis of reliable knowledge of the general distribution of a particular biological species and long-term fluctuations in the spatial contours of its populations over a historically long time period. The study of a complex of bird species within a compact territory is rarely presented at high

latitudes (Pryor 1968) in Antarctica. The breeding seabird populations of the Haswell archipelago and the Adams Island were chosen as a model for recording the above events. This was facilitated by the nearby Soviet-Russian station Mirny, which has been continuously operating since 1956.

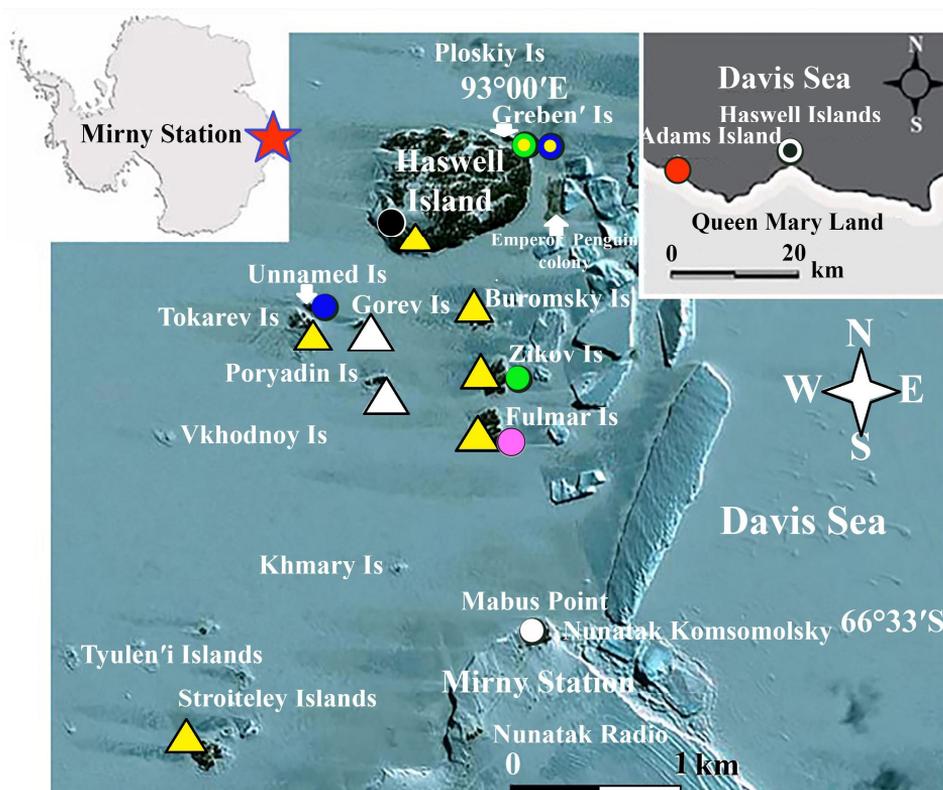
The aim of this work is a comprehensive compilation and analysis of historical and recent data of the spatial distribution of seabird breeding populations and breeding attempts in new, previously uninhabited territories. Objectives of the study were to evaluate: (1) establishment of regular or relatively regular breeding sites for seabird populations, (2) establishment of new breeding sites or attempts to breed bird species in previously uninhabited territories and (3) cataloging and identifying the status of previously uninhabited territories where breeding or attempted breeding of avian species was later recorded. The study attempts to contribute to the understanding of some local features of the recent spatial dynamics of breeding populations of penguins, procellariids and skuas off the coast of Antarctica.

## Study area, Material and Methods

Observations and population counts of seabirds were carried out at the Haswell archipelago, Queen Mary Land, Davis Sea, southern Indian Ocean, (Fig. 1) in the vicinity of the Mirny Station (66° 33' 11" S, 93° 00' 35" E) during the historical period – from 1912 to 2016.

The archipelago includes 17 islands and 4 coastal nunataks. The largest island in the archipelago is the Haswell Island. It has a territory of 0.82 km<sup>2</sup> and a height of 93 m. Komsomolsky and Radio nunataks are smaller. The main facilities of the Mirny

Station are located on them. Cape Mabus is the northernmost point of the peninsula where the station is located. The absolute heights of most of the islands ranges between 10 and 35 m above sea level. Islands and shoals are an insurmountable barrier to icebergs drifting along the coast of Antarctica to the west. Iceberg clusters, especially to the east of the islands, are a year-round addition to the local landscape (Fig. 1). The islands and nunataks have traces of glacial exaration on their surface (Voronov and Klimov 1960, Pryor 1968).



**Fig. 1.** Study area. *Note:* the left inset shows the location of the Mirny Station; the right inset shows the location of the colony of Adélie Penguins (*Pygoscelis adeliae*) on Adams Island (red circle) relative to the Haswell archipelago (black and white circle); sites of regular (yellow triangles) or relatively regular (white triangles) breeding populations of seabirds of the Haswell archipelago; probable (yellow-green circle) and new (green circle) breeding sites of Southern Fulmars (*Fulmarus glacialoides*); probable (yellow-blue circle) and new (blue circle) breeding sites of Cape Petrels (*Daption capense*); probable breeding (white circle) by the Wilson Storm Petrels (*Oceanites oceanicus*); a failed attempt of breeding by Antarctic Petrels (*Thalassoica antarctica*) at a new breeding site (pink circle); the new breeding sites (black circle) for mixed pairs of Brown Skua (*Stercorarius antarcticus*) × South Polar Skua (*Stercorarius maccormicki*).

Nine bird species breed in the study area ([1] - ASPA № 127): Emperor Penguin (*Aptenodytes forsteri*), Adélie Penguin (*Pygoscelis adeliae*), Southern Fulmar (*Fulmarus glacialoides*), Antarctic Petrel (*Thalassoica antarctica*), Cape Petrel (*Daption capense*), Snow Petrel (*Pagodroma nivea*), Wilson's Storm Petrel (*Oceanites oceanicus*), South Polar Skua (*Stercorarius maccormicki*) and subspecies Brown Skua (*Stercorarius antarcticus lonnbergi*).

Of these, the Emperor Penguin is listed as Near Threatened on the IUCN Red List of Threatened Species; the remaining 8 species of birds are listed as of Least Concern. Emperor Penguin and Adélie Penguin are vulnerable and require conservation measures. For the other 7 species of seabirds, no threats have been identified, and no conservation measures are stipulated ([2] - BirdLife International 2020).

Haswell Island – Antarctic Specially Protected Area № 127 ([1] - ASPA № 127) – is a place near which a colony of Emperor Penguins is located on the fast ice (Fig. 1). Eight species of birds breed on the island annually. Their total number is the highest in comparison with breeding sites on the other islands of the archipelago and the islands of the Davis Sea basin.

This report is based on a compilation of historical records from published literature and expedition reports. The historical records are supplemented by my own observations made from 8 January 2012 to 7 January 2013, and from 9 January 2015 to 14 January 2016. I surveyed all the nunataks, islands and islets of the archipelago on foot when fast ice was present. The total study area is 12 km<sup>2</sup>. Adams Island (Fig. 1) proved to be logistically inaccessible to me, but a single aerial census of penguins on the island was carried out in 2011 by Australian researchers (Southwell and Emmerson 2013a).

During the breeding season, new breeding sites of seabirds were visited by the author once (Greben' Island, Unnamed Island) or repeatedly (Haswell, Zykov, Fulmar Islands; Komsomolsky nunatak). During the observations, 8-20×binoculars were used. The digital images presented in this work were obtained by the author using a Canon 60D digital camera and Sigma 50-500 mm and Canon 70-200 long-focus lenses. The geographical coordinates of important places were established by a GPS navigator or taken from published resources. This publication makes use of the geographical names of islands and nunataks featuring in the Soviet and Russian scientific sources. Only one island to the north-northeast of Tokarev Island did not have a name. In this article, it appears as an Unnamed Island (Fig. 1).

Sites of regular or relatively regular breeding, as well as new breeding sites and attempts to breed seabirds in territories that were not populated in the historical

past, are presented in Tables 1 and 2, and Fig. 1. These tables are accompanied by an annotated list of breeding bird species. The main focus of the list is on the changes in settlement of previously uninhabited territories (where applicable). Estimation of new colony size and registration of single pairs in previously uninhabited territories were carried out in austral spring and summer from 1966 to early 2016 (Table 2). Aerial photographs were used to determine the breeding status and size of the Adélie Penguin colony (Adams Island, Southwell and Emmerson 2013a) or direct observations and counts from land (islands and nunataks of the archipelago, data from the author and colleagues) for procellariids and skuas. The taxonomy of birds mentioned in the text corresponds to the latest updates of the IOC World Bird List ([3] - Gill et al. 2022).

This work contains several important concepts that apply only to the historical period. They appear below in the text and Table 2: a new breeding site (NBS) is a discrete land area (island, nunatak) where previously non-breeding bird species were found breeding (egg clutches or chicks were observed); a new site of probable breeding (NSPB) – territorial individuals or pairs were found building nests or incubating birds without eggs, as well as pairs using nesting chambers during the breeding period, but the presence of eggs and chicks were not established; an unsuccessful breeding attempt in a new site (UAB) – loss of a clutch or a chick, disappearance of a incubating bird from its nest, death of adult birds when trying to breed in an uninhabited territory. Previously uninhabited territory is considered as a discrete fragment of land (island, nunatak), on which the breeding of individuals of a particular bird species was not recorded during historical (newest) time. Most of the small islands within the Haswell Islands can be considered examples of previously uninhabited territories since they are free of breeding birds. However, Fulmar

Island, inhabited by breeding Adélie Penguins, Southern Fulmars and South Polar Skuas, can be considered as previously uninhabited territory for Antarctic Petrels breeding on the Haswell Island, since there has been evidence of an unsuccessful breeding attempt by a pair of these petrels

on Fulmar Island. Also of note is that the concept of the new breeding sites (e.g., Southwell and Emmerson 2013b, Gryz et al. 2019) which is widely used in this publication is an analogue of the notion of "a new breeding locality" (Wilson 2009).

No.	Site / Bird species	<i>A. forsteri</i>	<i>P. adeliae</i>	<i>F. glacialoides</i>	<i>T. antarctica</i>	<i>D. capense</i>
1	Sea ice near Haswell Island	+	-	-	-	-
2	Haswell Island	-	+	+	+	+
3	Buromsky Island	-	+	-	-	-
4	Zykov Island	-	+	-	-	-
5	Fulmar Island	-	+	+	-	-
6	Tokarev Island	-	+	-	-	-
7	Gorev Island	-	-	-	-	-
8	Poryadin Island	-	-	-	-	-
9	Stroiteley Islands	-	+	-	-	-
	Number of occupied islands	0	6	2	1	1

No.	Site / Bird species	<i>P. nivea</i>	<i>O. oceanicus</i>	<i>S. mac-cormicki</i>	<i>S. antarcticus</i> × <i>S. maccormicki</i>	Number of species on each island
1	Sea ice near Haswell Island	-	-	-	-	-
2	Haswell Island	+	+	+	+	8
3	Buromsky Island	-	-	+	-	2
4	Zykov Island	-	-	+	-	3
5	Fulmar Island	-	-	+	-	3
6	Tokarev Island	-	-	+	-	2
7	Gorev Island	-	-	+	-	0-1
8	Poryadin Island	-	-	+	-	0-1
9	Stroiteley Islands	-	+	+	-	2-3
	Number of occupied islands	1	2	8	1	-

**Table 1.** Regular or relatively regular breeding sites for seabird species in the Haswell archipelago (1912-2016).

No.	Species	Location	Latitude	Longitude	Status
1	Adélie Penguin	Adams Island	66.5459°S	92.5486°E	NBS
2	Southern Fulmar	Greben' Island	66.6125°S	93°0394°E	NSPB
	Southern Fulmar	Zykov Island	66.5377°S	93.0025°E	NBS
	Southern Fulmar	Zykov Island	66.5377°S	93.0025°E	
3	Antarctic Petrel	Fulmar Island	66.5408°S	93.0011°E	UAB
4	Cape Petrel	Unnamed Island	66.5335°S	92.9735°E	NBS
	Cape Petrel	Greben' Island	66.6125°S	93°0394°E	NSPB
	Cape Petrel	Greben' Island	66.6125°S	93°0394°E	
5	Wilson's Storm Petrel	Nunatak Komsomolsky	66.5529°S	93.0097°E	NSPB
6	Brown Skua × South Polar Skua	Haswell Island	66.5258°S	92.9950°E	
	Brown Skua × South Polar Skua	Haswell Island	66.5258°S	92.9950°E	NBS
	Brown Skua × South Polar Skua	Haswell Island	66.5258°S	92.9950°E	

Table 2, continuation

No.	Species	Location	Count	Date of count	Sources
1	Adélie Penguin	Adams Island	425 adults and chicks	21.1.2011	Southwell, Emmerson 2013a
2	Southern Fulmar	Greben' Island	10 pairs and 12 singles adults	1.11.2012	Golubev, unpublished data
	Southern Fulmar	Zykov Island	4 pairs and 11 singles adults	2.12.2012	Golubev, unpublished data
	Southern Fulmar	Zykov Island	6 pairs, 11 singles and a group of 3 adults	1.12.2015	Golubev, unpublished data
3	Antarctic Petrel	Fulmar Island	Nest with egg	5.12.1966	Kamenev 1968a
4	Cape Petrel	Unnamed Island	Nest with an egg and empty nest	17.12.2012	Golubev, unpublished data
	Cape Petrel	Greben' Island	?	January 2010	Mizin 2010
	Cape Petrel	Greben' Island	3 pairs and 6 singles adults	1.11.2012	Golubev, unpublished data
5	Wilson's Storm Petrel	Nunatak Komsomolsky	1 pair	2005/2006-2015/2016	Mizin 2010, data of the Golubev and station personnel
6	Brown Skua × South Polar Skua	Haswell Island	2 mixed pairs	Season 2012/2013	Golubev, unpublished data
	Brown Skua × South Polar Skua	Haswell Island	1 mixed pair	Season 2014/2015	Golubev, unpublished data
	Brown Skua × South Polar Skua	Haswell Island	2 mixed pairs and 1 pair without a nest	Season 2015/2016	Golubev, unpublished data

**Table 2.** New and estimated breeding sites for populations of seabird species in the Haswell archipelago and Adams Island. *Note:* The explanation of abbreviations in the Status column is contained in the Materials and Methods section; "?" - no detailed information.

## Results

According to Table 1, the sites of regular and relatively regular breeding of birds within the archipelago are established on 8 islands – Haswell, Buromsky, Zykov, Fulmar, Tokarev, Gorev, Poryadin and the largest island of the group of Stroiteley Islands. Only the islands of Gorev and Poryadin are sites of relatively regular (not annual) breeding of single pairs of South Polar Skuas. The 6 other largest islands of the archipelago are annually used by populations of various bird species for breeding and serve as a stable long-term breeding ground for populations of all land-breeding species here. The smallest islands – Tyulen'i Islands, small islands in the group of Stroiteley Islands, Ploskiy, Vkhodnoy, Khmary, and other unnamed islets (Fig. 1) were unsuitable for breeding populations of seabird species.

In the sites of regular and relatively regular breeding on the islands (Table 1), populations of Snow Petrel, Wilson's Storm

Petrel and skuas formed spatially loose colonies. All other seabird species bred predominantly in denser and more compact colonies. Breeding of single pairs outside the colonies was not recorded only in the Emperor Penguin. Few single pairs and groups of 6 out of 9 breeding seabird species attempted to breed in new sites in previously uninhabited territories (Table 2) – on 6 islands and 1 nunatak. Adélie Penguins (n=1), Southern Fulmars (n=1), Cape Petrels (n=1) and Brown Skua × South Polar Skua mixed pairs (n=1) bred in new sites. New sites of probable breeding have been recorded in the Southern Fulmar (n=1), Cape Petrel (n=1) and Wilson's Storm Petrel (n=1). An unsuccessful breeding attempt in a previously uninhabited territory was observed in the Antarctic Petrel (n=1). The breeding populations of Emperor Penguin, Snow Petrel and South Polar Skua showed no principled changes in their spatial distribution.

### *Annotated list of breeding avian species*

#### *Seabird species that attempted to breed in previously uninhabited territories*

**Adélie Penguin.** Colonies of Adélie Penguins are located on 6 islands of the archipelago – Haswell, Buromsky, Zykov, Tokarev, Fulmar and Stroiteley (Mawson 1915, Korotkevich 1959, Arseniev 1960, Gollerbach and Syroechkovsky 1960, Pryor 1964a, 1968; Kamenev 1966, 1971; Starck 1980, Mizin and Chernov 2000, Mizin 2004, 2007, 2010; Dorofeev 2011, Golubev to unpublished data). During the historical period, the colonization of other islands or the extinction of colonies of Adélie Penguins inside the archipelago have not been revealed.

Adams Island is located just over 20 km west of the Mirny (Fig. 1). The island was discovered and mapped on November 25, 1912 by members of the Douglas Mawson expedition (Voronov 1969). 44 years later, on September 12, 1956, the Soviet geographer E. S. Korotkevich (1959) visited this island. For objective reasons, he did not find Adélie Penguins on it, since the arrival of penguins from the sea to the colonies usually took place in October. On November 11, 1956 (when Adélie Penguins were supposed to be on the nests – author's note), Soviet geologist P. S. Voronov examined the Adams Island for 2 hours. He noted that at that time the rocks of this island were bare and lifeless, although the researcher observed a single Leopard Seal (*Hydrurga leptonych*) on the sea ice near the island (Voronov 1969). Thus, the researchers of the D. Mawson expedition,

as well as E. S. Korotkevich and P. S. Voronov, had no evidence of the presence of Adélie Penguins on the island (observations of live birds, their carcasses or body fragments, droppings, guano stains, feathers and eggshells). To my best knowledge, since then and until recently, Adams Island has not been visited by ornithologists. Only on January 21, 2011, Australian scientists received aerial photographs of excellent quality on guano-covered rock of the Adams Island, and counted 425 adults and unguarded chicks (Southwell and Emmerson 2013a). Consequently, Adams Island became a newly discovered breeding site (Fig. 1) along the Queen Mary Land coastlines (Southwell and Emmerson 2013a). In this case, it is reasonable to assume that until the mid-1950s, the Adams Island was indeed not inhabited by Adélie Penguins and its occupation by penguins occurred later. Therefore, Adélie Penguin's colony of the Adams Island may be by result of relatively recent colonization. However, the date of the first attempt to colonize the island by Adélie Penguins has not been established.

***Southern Fulmar.*** Colonies of the Southern Fulmar were located on 2 islands of the archipelago – Haswell and Fulmar (Mawson 1915, Korotkevich 1959, Gollerbach and Syroechkovsky 1960, Pryor 1964b, 1968; Kamenev 1978, Starck 1980, Mizin and Chernov 2000, Mizin 2004, 2007, 2010; Dorofeev 2011, Golubev to unpublished data). However, in 2012, new small settlements of fulmars were first discovered on the islands of Greben' and Zykov.

Greben' Island. On November 1, 2012, 10 territorial pairs and 12 sitting single individuals were recorded on the island. Some individuals were clearing snow from the breeding grounds (Fig. 2A), others were already sitting on the nests. Nests and nesting territories were located in the range from 5 to 13 meters above sea level.

Zykov Island. During the winter of 2012, a snowdrift about 10 meters high formed near the southern part of the island, adjoining the rock and attracting fulmars to place nesting chambers in the snow. On October 22, several territorial pairs were seen sitting on the island for the first time. On October 27, 12 pairs and 9 sitting singles were counted there. Most of the individuals sat on the surface of the rock free from snow, the rest on a snowdrift. On November 1-2, single individuals were observed on the island, on November 11, according to visual estimates, the number of Southern Fulmars increased. On November 22, the birds actively lekked and built nests, their numbers reached the level observed on October 27. On December 2, 4 pairs and 11 sitting singles were counted on the island; in 1 of the 4 inspected nests, an egg was found under the incubating bird. By this time, only pairs of fulmars survived, occupying territories on the surface of the rock, free from snow and ice, since the snowdrift underwent melting and was significantly reduced in size. As the snowdrift decreased, the snow chambers of the territorial pairs of fulmars disappeared. Thus, the breeding of the Southern Fulmar on Zykov Island was first proven in 2012. In 2015, during the winter, a snowdrift in the south of the island formed again. On December 1, 6 pairs, 11 singles and a group of 3 individuals were counted on a snowdrift and a fragment of a rock free of snow and ice. Fulmars sitting on the nests did not have eggs.

**Antarctic Petrel** colony was located only on the Haswell Island (Mawson 1915, Korotkevich 1958, 1959; Gollerbach and Syroechkovsky 1960, Pryor 1964b, 1968; Starck 1980, Mizin and Chernov 2000, Mizin 2004, 2007, 2010; Dorofeev 2011, Golubev to unpublished data).

Fulmar Island. The first and only unsuccessful attempt to breed by Antarctic Petrels outside the colony on the Haswell Island was observed in the southern part of Fulmar Island: in 1966, from 24 November to 5 December, an Antarctic Petrel nested in the colony of Southern Fulmars; On December 5, an egg appeared in its nest, the next day the egg and the incubating bird disappeared (Kamenev 1968a).

**Cape Petrel** bred on Haswell Island (Mawson 1915, Korotkevich 1959, Arseniev 1960, Gollerbach and Syroechkovsky 1960, Pryor 1965, 1968; Kamenev 1968a, 1988; Starck 1980, Mizin and Chernov 2000, Mizin 2004, 2007, 2010; Dorofeev 2011, Golubev to unpublished data).

Unnamed island near Tokarev Island (Fig. 1). On December 17, 2012, a pair of adult Cape Petrels on a nest was found on the island in a deep horizontal crack under an overhanging boulder. One of the birds of the pair was incubating the egg (Fig. 2B). An empty nest was located near the active nest. Near the island, one adult individual made a circular flight. Both nests were well protected from predators by the roughness of the rock, but the possibilities for colony growth on this island were limited because of insufficient availability of the area for breeding.

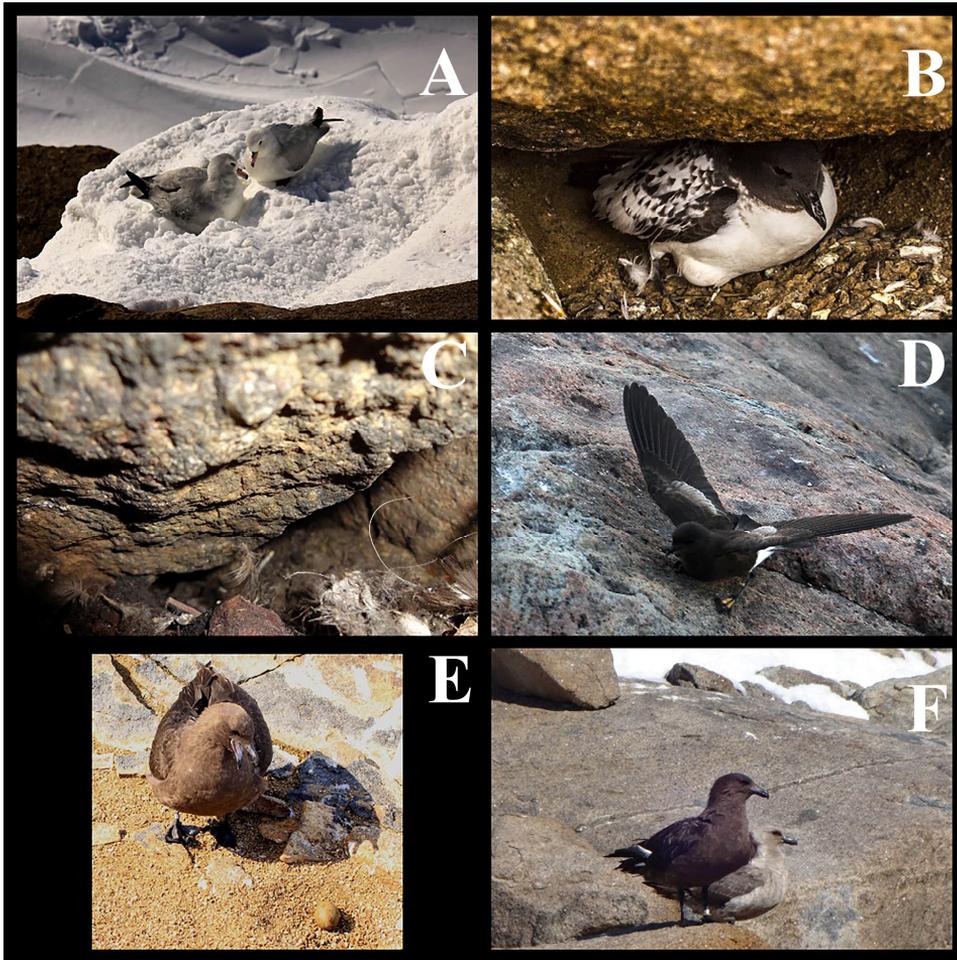
Greben' Island. In January 2010, the Cape Petrel colony was first discovered by I. A. Mizin (2010). November 1, 2012 I counted 3 pairs and 6 singles on this island. The birds actively lekked and cleared the breeding grounds from snow. All nesting territories of Cape Petrels were located at an altitude of more than 10 m above sea level.

**Wilson's Storm Petrel** breeds on Haswell and Stroiteley Islands (Korotkevich 1959, Gollerbach and Syroechkovsky 1960, Pryor 1965, 1968; Kamenev 1968a, 1977b; Starck 1980, Mizin and Chernov 2000, Mizin 2010, Golubev to unpublished data), one pair of storm petrels could breed on Fulmar Island (Golubev to unpublished data). Counts of Wilson's Storm Petrels on all islands of the archipelago were limited by the difficulties of finding nest sites under rocks and other reasons (Pryor 1968).

Nunatak Komsomolsky. In the second half of the 20<sup>th</sup> century, the snow-free nunataks of Antarctica in the vicinity of the Mirny Station were not inhabited by Wilson's Storm Petrels (Pryor 1968). Only 1 pair of storm petrels could regularly breed on the coast of Antarctica near the diesel power plant since the 2005/2006 breeding season (Mizin 2010, data of the Golubev and station personnel, Fig. 2C, 2D).

**Brown Skua × South Polar Skua.** The history of colonization of the archipelago by the Brown Skua began with the registration of a single individual, which was observed in the Mirny and on the Haswell Island by the austral summer of 2009/2010 (Mizin 2015).

Haswell Island. Since 2012, 1-2 mixed pairs of Brown Skuas (including alleged hybrids) with South Polar Skuas have bred regularly on the island (Fig. 2E). In 2015, 1 territorial hybrid pair was observed on the Haswell Island (Fig. 2F) that did not breed for unknown reasons. Pairs consisting only of Brown Skuas were not registered (Golubev to unpublished data).



**Fig. 2.** Images of some species of seabirds in previously uninhabited territories of the Haswell archipelago.

- A. A pair of Southern Fulmars (*Fulmarus glacialisoides*) clears the breeding ground from snow. Greben' Island. November 1, 2012.
- B. Cape Petrel (*Daption capense*) on a nest with an egg. Unnamed Island. December 17, 2012.
- C. The entrance hole to the nesting chamber of Wilson's Storm Petrels (*Oceanites oceanicus*). The Mirny Station, Komsomolsky nunatak. February 24, 2015.
- D. Wilson's Storm Petrel (*Oceanites oceanicus*) on the breeding territory. The Mirny Station, Komsomolsky nunatak. February 26, 2015.
- E. Brown Skua (*Stercorarius antarcticus*) at the nest with one egg. Haswell Island. November 11, 2012.
- F. A hybrid pair including a Brown Skua (*Stercorarius antarcticus*) (left) and a South Polar Skua (*Stercorarius maccormicki*) (right). Haswell Island. December 17, 2015.

*Seabird species that have not bred outside of traditional breeding grounds*

**Emperor Penguin.** A colony of Emperor Penguins is annually located on the fast ice near Haswell Island or in its immediate vicinity (Mawson 1915, Korotkevich 1958, 1959; Makushok 1959, Arseniev 1960, Pryor 1964c, 1968; Kamenev 1968b, Mizin and Chernov 2000, Mizin 2004, 2007, 2010; Dorofeev 2011, Golubev to unpublished data).

The location of the colony can vary from year to year and depend upon weather and local sea ice conditions. The maximum distance of the colony location from the Haswell Island in the period between the completion of its formation and the beginning of break-up in some breeding seasons can reach 4 km or more. The ecological and biological features of the Emperor Penguins, as well as their annual attraction to the placement of a colony near the largest island of the archipelago, allows us to consider it as a species with relatively unchanged spatial characteristics.

**Snow Petrel.** Snow Petrels breed only on Haswell Island (Mawson 1915, Korotkevich 1959, Gollerbach and Syroechkovsky 1960, Pryor 1965, 1968; Kamenev 1988, Starck 1980, Mizin and Chernov 2000, Mizin 2007, 2010; Dorofeev 2011, Golubev to unpublished data), although single pairs in some breeding seasons tried unsuccessfully to occupy territories for nesting on the Fulmar Island (Mizin 2007, 2010; Dorofeev 2011, Golubev to unpublished data).

**South Polar Skua.** South Polar Skuas breed on 8 islands of the archipelago (for example, Korotkevich 1959). The main place of annual breeding of the majority of the population is the Haswell Island. Some smaller islands of the archipelago are not used annually by skuas for breeding (Mawson 1915, Korotkevich 1959, Gollerbach and Syroechkovsky 1960, Pryor 1964a, 1968; Kamenev 1968a, Starck 1980, Mizin and Chernov 2000, Mizin 2010, 2015; Dorofeev 2011, Golubev to unpublished data). New breeding sites of South Polar Skuas in the studied territory have not been established during the historical period.

## Discussion

In breeding populations of seabirds, cases of colonization and attempts to breed in new places occur infrequently. Due to their rarity, they are difficult to study (Lynch and LaRue 2014, Southwell et al. 2017). A comparison of historical and recent occupation revealed discrepancies in spatial distribution associated with the discovery of new occupation sites by breeding populations of seabirds of the Haswell archipelago. In historical retrospect, the spatial distribution of these populations on the Haswell Islands, for example, turned out to be conservative. However, the first clear indication of the dynamism of the

spatial contours of bird populations in historically changing environmental conditions was obtained in the second half of the 20<sup>th</sup> century during an attempt to breed by Antarctic Petrel on Fulmar Island (Table 2). The majority of breeding attempts in new breeding sites occurred at the beginning of the 21<sup>st</sup> century. From 2005 to 2016, such events were proven for the Southern Fulmar, Cape Petrel, Wilson's Storm Petrel and mixed pairs of Brown Skua × South Polar Skua (Table 2), as mentioned above. Rare single pairs and groups of individuals of different sizes of 6 species in breeding populations of sea-

birds showed some susceptibility to changes in environmental conditions. Breeding of Adélie Penguins and tube-nosed bird species in new, previously uninhabited sites could be a consequence of the impact of predators, changes in local weather conditions and human activity. The hypothesis of avoiding breeding by some pairs or groups of seabirds in numerically growing colonies of their own species is not considered in this work. Antarctic penguins and tube-nosed bird species showed negative population trends during the historical period against the background of positive trends and a noticeable increase in the number of only local populations of both species of skuas (unpublished author's data).

Marine mammalian predators such as the Killer Whale (*Orcinus orca*) and the Leopard Seal cannot be a factor that has a strong impact on breeding populations of seabirds. These predators hunt Antarctic penguins, but they are rare in the archipelago area, and are usually found in a short period when the water area is free of fast ice. However, attempts to breed by seabirds in previously uninhabited territories may be a consequence of their avoidance of the predation by South Polar Skuas. The population size of the South Polar Skuas in the second half of the 20<sup>th</sup> century was (average (min-max)) 28.7 (18-47) pairs, n=4 (Korotkevich 1959, Pryor 1968, Kamenev 1968a, Mizin and Chernov 2000), at the beginning of the 21<sup>st</sup> century – 73.6 (62-83) pairs, n=3 (Mizin 2015, Dorofeev 2011, Golubev to unpublished data). Thus, the size of the population of skuas at the beginning of the 21<sup>st</sup> century increased 2.5 times in comparison with the second half of the 20<sup>th</sup> century. These marine top predators are food generalists (Reinhardt et al. 2000), and on the Haswell Islands they feed on the more abundantly presented bird species – Emperor Penguins and Adélie Penguins. At the beginning of the breeding season, South Polar Skuas feed on lost eggs, dead (frozen) chicks and rare corpses of adult Emperor Penguins. With the ex-

ception of rare cases of predation on chicks (Pryor 1968, Kamenev 1977a), skuas do not exert predatory pressure on live Emperor Penguins. However, skuas predate on eggs and chicks of Adélie Penguins (Gollerbach and Syroechkovsky 1960, Pryor 1968, Kamenev 1971) at the height of the breeding season. Eggs, chicks and adult Southern Fulmars are consumed less often than penguins, but more often than other tube-nosed bird species. Only some pairs of South Polar Skuas predate in colonies of fulmars (Pryor 1968, Kamenev 1978). The contribution of other bird species to the food supply of skuas is small (Pryor 1968), since predation on adult Cape Petrels is minimal (the author's observations), and the loss of eggs of Antarctic Petrels from raids of skuas is insubstantial (Pryor 1964b). There is no direct evidence of the use of Wilson's Storm Petrels in the diet of South Polar Skuas. Thus, the hypothesis of the increased influence of South Polar Skuas on breeding populations of seabirds as a whole satisfactorily explains their attempts to breed in previously uninhabited territories and the avoidance of predators by Adélie Penguins, Southern Fulmars and Cape Petrels. Predation of rare Brown Skuas on seabirds may be an additional argument in favor of the hypothesis of increased predation of skuas on seabird populations, but the details of their feeding behavior and diet have not yet been investigated.

Changes in local weather conditions, especially those associated with changes in wind direction, accumulation and redistribution of snow masses may be a factor contributing to attempts to breed by seabirds in uninhabited territories and the formation of new settlements, colonies. This is consistent with attempts to breed by Southern Fulmars on the Zykov Island, where a high snowdrift, which formed during winter, turned out to be attractive for breeding by several pairs of Southern Fulmars at once. However, it is assumed that in this case, changes in local weather con-

ditions only contributed to the fulmars in attempts to avoid predation of the skuas. The new sites of probable breeding of Wilson's Storm Petrel on the Komsomolsky nunatak is unlikely to be associated with predation by skuas. Repeated use of this previously uninhabited territory may be the reason for changes in the distribution of snow masses on the rocky surface of the nunatak, which provided access to the nesting chamber for birds during the breeding season.

In the short period of the absence of fast ice, human activity does not affect the island breeding populations of birds. Scientific (zoological) studies have some concern for island seabird colonies during the breeding season, usually from October to December, when the fast ice is present. On the way to the Mirny Station, R/V Akademik Fedorov breaks the fast ice and creates inconvenience to Adélie Penguins moving from the sea to the colonies or leaving them. The concern of birds, especially Adélie Penguins, is observed during helicopter operations carried out from the R/V Akademik Fedorov during short-term logistics operations in the austral summer. In general, human activity does not seem to be the reason that allows for attempts by seabirds to breed in new, previously uninhabited territories.

Individuals which have attempted or bred in previously uninhabited territories have not been attributed to specific populations. Nevertheless, Adélie Penguins and all tube-nosed bird species could be native or belong to other populations, although Brown Skuas were not native. The observed birds had no means of individual identification on the body (rings, tags, dyes, *etc.*). But invasive Brown Skuas wore rings and plastic tags on their legs, hung by biologists in the Mirny for the next 7 years starting from the 2009/2010 season, which also does not clarify the question of the origin of these birds.

A special case of breeding in a new site is the introduction (invasion) of Brown Skuas

as into local assemblies of breeding birds and their subsequent naturalization on the Haswell Islands. Brown Skuas breed in the Antarctic and sub-Antarctic islands (Ritz et al. 2008), the main part of the species' range is located in sub-Antarctic. We are witnessing for the first time the initial stage of colonization of the Haswell archipelago by Brown Skuas through the formation of hybrid pairs with South Polar Skuas. The initial stage of colonization of the archipelago by Brown Skua is most likely associated with the natural settlement of the species outside its natural breeding range. Feeding territories of nesting Brown Skuas and alleged hybrids were located in the colonies of Antarctic penguins. Brown Skuas also visited a garbage dump in the Mirny Station, where they successfully competed in active obliged aggregations, and often dominated the kitchen garbage over the South Polar Skuas.

Now we can ascertain with confidence only relatively stable long-term locations of breeding populations of seabird species on the islands of the archipelago (Table 1). These sites are actually optimal in local conditions for long-term and annual maintenance of breeding of populations of tens of thousands of birds off the coast of Antarctica. Along with this, rare records of bird breeding events outside of their regular breeding sites in the historical and recent past can be considered as suboptimal breeding sites. Indirectly, this is confirmed by well-documented unsuccessful breeding attempts of Antarctic Petrels on the Fulmar Island and several pairs of Southern Fulmars on the Zykov Island, as mentioned above. Apparently, the breeding success of such pairs or groups of breeding individuals is low, since they probably had no experience of breeding in new sites in uninhabited territories. Studies of the occupation of previously uninhabited territories by birds will allow us to better understand the features of the initial stage of colonization of new sites of the Antarctic land by avian species in the recent past and deter-

mine their trends in the near future. Details of the duration of the existence of new colonies, their growth or degradation, the suc-

cess of breeding birds in previously uninhabited territories and relationships with predators will be useful in further research.

## Conclusion

A retrospective analysis of the data, combined with field observations and population counts, established the conservativeness of the spatial distribution of breeding seabird populations. Rare attempts to develop new breeding sites by birds were made only by a few single pairs or relatively small groups belonging to 6 of the 9 breeding species of the studied territory. A significant increase in the population size of South Polar Skuas during the historical period, the invasion and initial natu-

ralization of Brown Skuas on the Haswell Islands, as well as increased breeding attempts and occupation of new breeding sites in previously uninhabited territories by Adélie Penguins and tube-nosed bird species at the beginning of the 21<sup>st</sup> century, indicate changes in environmental conditions in the local ecosystem. These conditions are probably a consequence of the regional climate-induced changes occurring in the global ecosystem of East Antarctica.

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