Red Phalarope *Phalaropus fulicarius* and Red-necked Phalarope *Phalaropus lobatus* behavioural response to Arctic Tern *Sterna paradisaea* colonial alarms

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(Med et dansk resumé: Thorshanes og Odinshanes respons på alarmer i en havternekoloni)

Abstract The breeding association between Arctic Terns and Red and Red-necked Phalaropes has been mentioned several times in the ornithological literature, though mostly anecdotally. The present study, conducted at the Kitsissunnguit archipelago in western Greenland, investigates phalarope behavioural response to Arctic Tern colonial alarms, specifically the relationship between type and duration of tern alarms and phalarope response type. The majority of tern alarms elicited a visible response from the phalaropes. No difference in phalarope response type was detected between true alarms (tern responses to the presence of gulls, falcons or humans) and dreads (false alarms). Tern alarms to which the phalaropes reacted were of longer duration than alarms that caused no change in phalarope behaviour, whereas no relationship was found between tern alarm duration and phalarope response type (passive vs active). In conclusion, phalaropes respond strongly to tern alarms, but do not differentiate between predator-related alarms and dreads. These findings support the view that phalaropes, where possible, take advantage from Arctic Tern colonies, and that this relationship – fulfilling the criteria of both the *information parasitism* and the *defence parasitism hypotheses* – explains the high densities of phalaropes at Kitsissunguit.

Introduction

Beneficial breeding associations are well known in multi-species colonies of birds. Many examples are known among colonial waterbirds (e.g., Alberico et al. 1991). Typically, such relationships form between a semi-aggressive, bold species (often a larid) and a more timid species of waterbird, where the latter benefits from the strong colony defence of the bold species. In most of these cases, however, the details of the relationship are unknown and the mechanism through which the timid species benefits from the breeding association has not been documented.

In order to obtain a higher individual survival and reproductive output, a timid species can benefit from breeding associations with more aggressive species if the bold species provides a higher predator detection rate and/or predator detection at a greater distance, giving the timid species more time to react (the *information parasitism hypothesis*, Nuechterlein 1981); or if the bold species aggressively defends the surroundings of its nest and thereby indirectly provides protection to the timid species (*defence parasitism hypothesis*, Dyrcz et al. 1981).

Arctic Terns *Sterna paradisaea* have been known to associate with high breeding densities of several species of shorebirds, including Red-necked Phalarope *Phalaropus lobatus* and Red Phalarope *Phalaropus fulicarius* (Løvenskiold 1964, Hildén & Voulanto 1972, Cramp & Simmons 1983, Egevang et al. 2004), Ruddy Turnstone *Arenaria interpres* (Brearey & Hildén 1985) and Purple Sandpiper *Calidris maritima* (Summers & Nicoll 2004).

The present study focuses on the association between Arctic Terns and phalaropes in a major Arctic Tern colony in western Greenland. Using relatively simple observations of phalarope response to tern alarms and dreads (false alarms), we investigate whether phalaropes use information parasitism to benefit from the terns, and which behavioural responses they express.

Study area and methods

Fieldwork was conducted at the Kitsissunnguit (Grønne Ejland) archipelago in the southern part of Disko Bay, West Greenland (68˚50'N, 52˚00'W) in the period 2-28 July, 2006. Kitsissunnguit is the largest Arctic Tern colony in Greenland with 16000-22000 estimated breeding pairs in 2002-2006 (Egevang et al. 2004; this study). By Arctic standards, the site holds a rich avifauna with 25 breeding species recorded, some of them rare in West Greenland (e.g., Red Phalarope, Long-tailed Skua *Stercorarius longicaudus*, Ross's Gull *Rhodostethia rosea*, cf. Kampp & Kristensen 1980, Kampp 1982, Frich 1997). The major avian predators are Glaucous Gull *Larus hyperboreus*, Great Black-backed Gull *Larus marinus,* Gyrfalcon *Falco rusticolus*, Peregrine Falcon *Falco peregrinus* and Raven *Corvus corax*. Arctic fox *Alopex lagopus* also occur at the archipelago where it occasionally breeds, and although Arctic Terns and foxes may co-exist at Kitsissunnguit for a few years (Kampp 1982), the terns probably avoid the easternmost island in the archipelago because foxes have been established there for decades (Egevang et al. 2004). The coasts of the islands are generally rocky, whereas the inland is covered by dwarf scrub heath with willow *Salix* spp., dwarf birch *Betula nana* and crowberry *Empetrum nigrum* as the dominant plant species. There are many moist areas, ponds and small lakes with sedge *Carex* spp. and cotton grass *Eriophorum* spp.

The current study was conducted at Basisø, a fox-free island of approximately 3.5 km^2. In 2006 there were 45 pairs of Red-necked Phalaropes and 7 of Red Phalaropes on the island, which numbers may underestimate the actual number of nests because females may be polyandrous (Cramp & Simmons 1983).

Observations of phalarope and tern behaviour were conducted from the edge of two small ponds. All phalarope individuals present at the ponds during an observation period were kept under observation. The three main behaviours performed by phalaropes outside tern alarm periods were feeding, resting and preening. Observation periods varied from one to three hours, in total covering 30 hours, and were evenly distributed over the study period. Initially the phalaropes preferred a pond of c. 2500 m^2, but after the first week the behaviour of the birds changed and, apparently as a result of the fledging of the chicks, they began to frequent a new pond adjacent to the first. Both sites offered a good view of the water surface and the brinks. Apart from the phalaropes and a high number of Arctic Terns, the breeding species in the surrounding area were Mallard *Anas platyrhynchos*, Long-tailed Duck *Clangula hyemalis*, and Red-breasted Merganser *Mergus serrator*.

Both phalarope species were included in the study but no distinction between them were made, due to their very similar behaviour and response to aerial predators. The dataset mainly includes local breeders but, as the season advanced, these became mixed with migrants and with local juveniles.

The following behavioural patterns were recorded:

Tern alarms. The duration of tern alarms, defined as mass up-flight by at least half of the terns in the study area, was recorded. The type of alarm was categorized as a) originating from disturbance from gull or falcon, b) originating from human disturbance, or c) dreads (false alarms).

Phalarope response to tern alarms. During tern alarms the behavioural response of the phalaropes was recorded. Six different types of response were identified: 1) no response (no change in behaviour), 2) tucking to water surface (*Tucking*), 3) stopping ongoing behaviour and/or looking up (*Stop/looking up*), 4) take-off from pond (*Upflight*), and 5)

Table 1. Behavioural response of Red Phalarope and Red-necked Phalarope to Artic Tern alarms during 30 hours of observation at Kitsissunnguit in 2006. Arctic Tern alarms were caused by present gulls/falcons or humans, or were dreads (false alarms). The six different types of phalarope behavioural responses were: 1) No reaction (i.e. no change in behaviour); 2) Tucking (i.e. tucking to water surface); 3) Stop/looking up (i.e. stopping ongoing behaviour and/or looking up); 4) Upflight (i.e. take off from pond; 5) Swim surface (i.e. swimming out on pond surface), and; 6) Swim brink (i.e swimming to the brink).
Adfærdsrespons fra Thorshane og Odinshane på havternealarmer under 30 observationstimer på Kitsissunnguit i 2006. Havternealarmerne var fordelt på måger/falke, mennesker og falske alarmer (henholdsvis 2., 3. og 1. kolonne). De seks typer af adfærdsrespons var: 1) Ingen reaktion (ingen ændring i adfærd); 2) Trykkende (til vandfladen); 3) Stop/kig op (stopper igangværende adfærd og/eller kigger op); 4) Opflyvning (letter fra dam); 5) Svømmer ud på vandfladen; 6) Svømmer ind til brinken.

	Tern Alarm Type			Total
	Dreads	Gull/Falcon	Human	
1) No reaction	6	4	1	11
2) Tucking	1	1	-	2
3) Stop/look up	28	8	-	36
4) Upflight	8	4	1	13
5) Swim surface	2	-	-	2
6) Swim brink	5	1	-	6
Total	50	18	2	70

swimming out on pond surface or 6) to the brink (*Swim surface/brink*). Phalarope response during each tern alarm sometimes included more than one of these types, but only the predominant one was included in the statistical analysis.

Response types 2) and 3) were classified as *passive*, types 4), 5) and 6) as *active*.

The frequency distributions of phalarope responses were statistically tested using χ^2-tests. Mann-Whitney U-tests were used to test the difference in duration of tern alarms grouped on basis of phalarope response.

Results

The terns responded strongly to predators within the boundaries of the colony, and the presence of aerial predators resulted in fierce mobbing behaviour involving hundreds, on a few occasions thousands of birds. The type and intensity of the vocalisation of the terns varied somewhat, depending on the predator species, so that at least three types of alarm calls (falcon, gull, human) could be distinguished in the field. The mean duration of gull/falcon alarms was 30.3 s (n=17), which is longer than the mean duration of dreads (23.0 s, n=44) (Mann-Whitney U-test, U=239.5, P<0.05).

The mean number ± SD of phalaropes observed in each period was 16.8 ± 10.5. We recorded 70 alarms in total, and their types and the corresponding phalarope behaviours are shown in Table 1. The mean frequency ± SD of tern upflights was 2.6 ± 1.3 hour^{-1}. The frequency of gull/falcon alarms was 0.26 hour^{-1}, while dreads comprised 71% of all alarms. The phalaropes never reacted to an intruding predator before the terns alarmed, and in the few cases where a gull was observed close to the colony without releasing alarm from the terns, no anti-predator behaviour was observed from the phalaropes.

Phalaropes responded visibly to most of the tern alarms, 59 out of 70 (Table 1; χ_1^2 = 31.56, Yates-correction, P<0.001). The most common responses were Upflight and Stop/look up. No difference in the distribution between missing, active and passive responses to dreads or gull/falcon/human alarms could be detected (χ_2^2 = 1.98, P = 0.37). The most common form of response in both cases was the passive response behaviour (dreads: 58%, n=50; gull/falcon/human: 45%, n=20).

Tern alarms to which phalaropes reacted visibly were of longer duration (26.5 s, n=52) than alarms eliciting no response from the phalaropes (16.1 s, n=9) (Mann-Whitney U-test, U=110.5, P<0.05). No difference was found between the duration of tern alarms to which phalaropes responded passively (23.3 s, n=36) and actively (33.8 s, n=16), respectively (Mann-Whitney U-test, U=226, P>0.05).

Discussion

The study on phalarope behavioural response to Arctic Tern alarms at Kitsissunnguit reveals a close association between the species. The phalaropes reacted instantly to tern alarms in 84% of the recorded alarms, indicating a one-way transfer of information from terns to phalaropes, as implied by the *information parasitism hypothesis*. At large Arctic Tern colonies (such as Kitsissunnguit) a predator will be detected at a considerable distances, and the intensity of the alarm will increase as the predator travels through the colony. This provides terns and other birds in the colony with an early warning system, passing on information on direction, distance and species of the approaching predator. This early warning gives the breeding birds the time necessary to perform anti-predator behaviour and warn offspring to seek cover.

Spontaneously occurring dreads without an obvious cause are common in tern colonies. The reason is not known; among the proposed causes is that it may contribute to the maintainance of pair bonds (Cullen 1960), and irrespective of the underlying cause the dreads may serve as an indicator of the frequency of predator visits to the colony (Meehan & Nisbet 2002). In the present study more than two thirds of the recorded alarms were dreads. The fact that phalaropes did not show any difference in behavioural response to dreads versus alarms involving predators indicates that the phalaropes react to tern alarms before they have visually identified a potential predator.

Tern alarm intensity and duration depends on the predator species, but also on how close the predator is to a given part of the colony and of the behaviour exhibited by the predator. For example will low hunting flights result in much more intense alarms from the terns than straight transits above the colony. These factors may also contribute to explaining why phalaropes apparently do not differentiate between real tern alarms and dreads, even though predatory alarms on average last longer than dreads, and phalaropes respond more frequently to longer alarms.

The dominance of passive responses to active ones may serve to lower depredation on eggs or chicks, since it allows the phalarope to stay in its territory, whereas the upflight response means that it has to leave, even in the case of a false alarm (Alberico et al. 1991).

The mean frequency of tern upflights (2.6 hour^{-1}) is comparable to the mean rate of 2 hour^{-1} quoted by Cramp (1985); it may, however, vary through the breeding period (Cramp l.c.). The frequency of gull/falcon alarms at Kitsissunnguit (0.26 hour^{-1}) is lower than the about 4 hour^{-1} – caused by Herring Gull alone – found during the hatching and chick rearing stage in a small (505 pairs) mixed tern colony in Canada (Whittam & Leonard 1999). This may indicate that predator numbers are relatively low at Kitsissunnguit. The many terns in the colony form an effective defence towards intruders such as Ravens, gulls and skuas. However, falcons are able to outfly the terns and are less affected by their mobbing (Egevang et al. 2005).

Egevang et al. (2004) documents that a marked decline in phalarope numbers took place after Arctic Terns abandoned the easternmost island in the Kitsissunnguit archipelago, Angissat. In addition, they discuss whether the unusually high breeding density of Red-necked Phalarope – and the presence of the rare Red Phalarope – at Kitsissunnguit is a direct result of the presence of a major tern colony, i.e., if the distribution of terns determines the distribution of phalaropes, or if both terns and phalaropes simply prefer a fox-free environment so that the presence or absence of foxes determines the distribution of both terns and phalaropes. The results of the present study verify the strong behavioural response of phalaropes to tern alarms, showing that the relationship between the species fulfils the criteria of both the *information parasitism* and the *defence parasitism hypothesis*, and thereby strengthen the first hypothesis, without being able to reject the second.

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Resumé

Thorshanes og Odinshanes respons på alarmer i en havternekoloni

Den positive ynglerelation mellem svømmesnepperne Thorshane *Phalaropus fulicarius* og Odinshane *P. lobatus* på den ene side, og Havternen *Sterna paradisaea* på den anden, er velkendt, men er oftest behandlet rent anekdotisk i den ornitologiske litteratur. Fra den 2. til 28. juli 2006 undersøgte vi de to svømmesneppers adfærdsrespons på kollektive havternealarmer på øgruppen Kitsissunnguit (Grønne Ejland) i Disko Bugt i Grønland. Undersøgelsen blev foretaget ved relativt simple observationer af typen

Phalaropes breeding in tern colonies use tern alarms (upflights and calls) as warning signals indicating the presence of predators, but are unable to distinguish between true and false alarms. Photo: Mikkel Willemoes Kristensen.

og længden af havternealarmerne og typen af svømmesneppernes respons herpå.

Hyppigheden af havternealarmer på hvilke svømmesnepperne responderede var signifikant højere end alarmer uden respons. Der blev ikke fundet nogen forskel mellem falske ternealarmer og ternealarmer forårsaget af måger, falke eller mennesker hvad angår hyppighed og fordeling af manglende respons, passiv respons, og aktiv respons. Alarmer af den sidstnævnte type var dog af signifikant længere varighed end falske alarmer. Ternealarmer med svømmesneppe-respons varede i gennemsnit længere end alarmer uden respons, mens der ikke var nogen tilsvarende signifikant forskel på længden af ternealarmer med henholdsvis aktiv og passiv svømmesneppe-respons.

Resultaterne viser, at svømmesnepperne reagerer markant på ternealarmer, og at de i deres respons ikke skelner mellem rovdyrsrelaterede alarmer og falske alarmer. Resultaterne understøtter formodningen om, at den høje yngletæthed af Odinshane – og tilstedeværelsen af Thorshane – på Kitissunnguit skyldes at ynglende svømmesnepper tiltrækkes af havternekolonier.

References

Alberico, J.A.R., J.M. Reed & L.W. Oring 1991: Nesting near a Common Tern colony increases and decreases Spotted Sandpiper nest predation. – Auk 108: 904-910.

Brearey, D. & O. Hildén 1985: Nesting and egg-predation by Turnstones *Arenaria interpres* in larid colonies. – Ornis Scand. 16: 283-292.

Cramp, S. & K.E.L. Simmons (eds) 1983: The birds of the western Palearctic. Vol. 3. – Oxford University Press.

Cramp, S. (ed.) 1985: The birds of the western Palearctic. Vol. 4. – Oxford University Press.

Cullen, J.M. 1960: The aerial display of the Arctic Tern and other species. – Ardea 48: 1-37.

Dyrcz, A., J. Witkowski & J. Okulewicz 1981: Nesting of timid waders in the vicinity of bold ones as an anti-predator adaptation. – Ibis 123: 542-545.

Egevang, C., K. Kampp & D. Boertmann 2004: The breeding association of Red Phalaropes with Arctic Terns: response to a redistribution of terns in a major Greenland colony. – Waterbirds 27: 406-410.

Egevang, C., D. Boertmann & O. Stenderup Kristensen 2005: Monitering af havternebestanden på Kitsissunnguit (Grønne Ejland) og i den sydlige del af Disko Bugt, 2002-2004. – Techn. rep. 62, Pinngortitaleriffik/ Grønlands Naturinstitut.

Hildén, O. & S. Voulanto 1972: Breeding biology of the red-necked phalarope *Phalaropus lobatus* in Finland. – Ornis Fenn. 49: 57-85.

Kampp, K. 1982: Notes on the Long-tailed Skua *Stercorarius longicaudus* in West Greenland. – Dansk Orn. Foren. Tidsskr. 76: 129-135.

Kampp, K. & R.M. Kristensen 1980: Ross's Gull *Rhodostethia rosea* breeding in Disko Bay, West Greenland, 1979. – Dansk Orn. Foren. Tidsskr. 74: 129-135.

Løvenskiold, H.L. 1964: Avifauna Svalbardensis. – Norsk Polarinstitut, Oslo.

Meehan, T.D. & I.C.T. Nisbet 2002: Nest attentiveness in common terns threatened by a model predator. – Waterbirds 25: 278-284.

Nuechterlein, G.L. 1981: Information parasitism in mixed colonies of Western Grebes and Forster's Terns. – Anim. Behav. 29: 985-989.

Summers, R.W. & M. Nicoll 2004: Geographical variation in the breeding biology of the Purple Sandpiper *Calidris maritima*. – Ibis 146: 303-313.

Whittam, R.M. & M.L. Leonard 1999: Predation and breeding success in Roseate Terns. – Can. J. Zool 77: 851-856.

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