1 Low frequencies of supernormal clutches in the Southern Dunlin and the Temminck's Stint

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31 Abstract

32 Supernormal clutches are found across bird species. Such clutches often result from more than one
33 female laying eggs in the same nest and can reflect different behaviors from parasitism to laying
34 mistakes. Enlarged clutches are readily visible among waders due to a maximum maternal clutch
35 size of four eggs, yet surprisingly little is known about this phenomenon. Since supernormal
36 clutches are rare, large sample sizes are required to reliably quantify their natural frequencies. We
37 used a large dataset to estimate the frequency of supernormal clutches in the polygamous
38 Temminck's Stint (*Calidris temminckii*) and the monogamous Southern Dunlin (*C. alpina schinzii*),
39 and examine the timing of supernormal clutches in relation to the general distribution of nest
40 initiation dates. While supernormal clutches were very rare, they were over four times more
41 common in the Temminck's Stint (0.50%, n = 1594) than in the Southern Dunlin (0.11%, n =
42 2766). Dunlin show among the lowest reported frequency of supernormal clutches among waders.
43 In the Temminck's Stint, supernormal clutches were found in the middle of the season, while in the
44 Southern Dunlin such clutches occurred in late season replacement nests. The higher rate and
45 timing of enlarged clutches in Temminck's Stints probably relates to the species' breeding system,
46 which can include simultaneous courtship of multiple partners, but more work is needed for
47 assessing the relative influence of different factors. We argue that intraspecific nest parasitism is
48 unlikely as a primary reproductive tactic in small sandpipers.

49 Keywords: *Calidris alpina schinzii*, *Calidris temminckii*, enlarged clutch, intra-specific nest
50 parasitism, quasi-parasitism, polygyny, shorebird, wader

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1. Introduction

Female birds tend to lay clutches which are optimal in relation to the number of eggs they are able to incubate, or the number of chicks they can successfully raise (Lack 1947, Monaghan & Nager 1997). Nevertheless, larger than optimal clutches have been observed in many avian species groups (Conover 1984, Geffen & Yom-Tov 2001, Yom-Tov 2001, Wojczulanis-Jakubas & Jakubas 2010). These supernormal clutches are often considered to have been laid by more than one female and to generally reflect intra-specific nest parasitism (e.g. Andersson 1984, Yom-Tov 2001, but see Grønstøl *et al.* 2006), which has been reported from over 200 bird species (Yom-Tov 2001). However, such clutches may also result from quasi-parasitism, polygyny, female-female pairings, laying mistakes and even from abnormal laying by one female (e.g. Mundahl *et al.* 1981, Conover 1984, Küpper *et al.* 2004, Colwell 2010).

Intriguingly, the upper limit of individual clutch size in waders (shorebirds) is four eggs (Maclean 1972, Walters 1984) even though females are physiologically able to lay more than four eggs within one season (Mundahl *et al.* 1981, Oring *et al.* 1983, Thomson *et al.* 2014), a feature also shown by egg removal experiments (Yogev *et al.* 1996; Wallander & Andersson 2003). Four eggs is also the most common clutch size and appears to be optimal for overall fitness (Sandercock 1997, Arnold 1999, Wallander & Anderson 2002, Larsen *et al.* 2003). The fixed maximum clutch size of this group makes it easier to spot the rare occasions when nests contain additional eggs (e.g. Nethersole-Thompson & Nethersole-Thompson 1986, Summers & Whitfield 2004, Christian & Hancock 2009, Kalejta-Summers & Summers 2015). The mechanisms responsible for this phenomenon are poorly known within wader species because few studies have quantified the frequency of supernormal clutches or examined factors influencing the variation in the number of these clutches (e.g. Nethersole-Thompson & Nethersole-Thompson 1986; Colwell 1986, Amat 1998, Hötter *et al.* 2000, Küpper *et al.* 2004). Depending on processes that produce supernormal clutches, their

78 frequencies may differ by species, sex of the incubator in uniparentally incubating species and
 79 differences in timing.

80 We use a large dataset including observations from seven countries spanning six decades to
 81 estimate the frequency of supernormal clutches in the Temminck's Stint (*Calidris temminckii*) and
 82 the Southern Dunlin (*C. alpina schinzii*). We describe the timing of supernormal clutches in relation
 83 to the general distribution of nest initiation dates. In contrast to the monogamous Dunlin, the
 84 Temminck's Stint exhibits sequential polygamy where nests are incubated by both sexes, but only
 85 by one parent per nest (Hildén 1975, Breiehagen 1989, Thomson *et al.* 2014). We therefore also
 86 describe frequencies of supernormal clutches separately for clutches incubated by male and female
 87 Temminck's Stints. Finally, we use our results together with published sources to discuss possible
 88 causes responsible for creating supernormal clutches in waders.

89

90 2. Material and methods

91 We used clutch size data from several sources to estimate frequencies of supernormal clutches.
 92 Firstly, we used original data from long-term life history studies collected while studying colour
 93 ringed populations. Temminck's Stint data were collected at Bothnian Bay in Kokkola, Finland (63°
 94 52' N, 23° 05' E; Hildén 1975) and near the city of Oulu, Finland (64° 50' N, 25° 00' E, Pakanen *et*
 95 *al.* 2011), in Enontekiö, Lapland (68° 38' N, 24° 40' E, Tracy *et al.* unpublished data) and at Finse,
 96 S Norway (60° 36' N, 7° 30' E, Breiehagen 1989). Southern Dunlin data included long term studies
 97 from Tipperne, Denmark (55° 53' N, 08° 12' E, Pakanen & Thorup 2016), from Pori, Finland (61°
 98 30' N, 21° 40' E, Soikkeli 1970), in the Bothnian Bay, Finland during (64° 50' N, 25° 00' E;
 99 Pakanen *et al.* 2017), at the south-west coast of Sweden (57° 55' N, 11° 47' E – 57° 07' N, 12° 14'
 100 E, Blomqvist *et al.* 2010), southern Sweden in Foteviken (55° 27' N, 12° 58' E; P. Olsson,

101 unpublished) and in the Matsalu region in west Estonia (58° 45' N, 23° 37' E, Pehlak *et al.*
 102 unpublished data).

103 Field methods were similar across the studies mentioned above and started with nest searching early
 104 in the season (see e.g. Pakanen *et al.* 2014). We did not include clutch sizes that were observed
 105 during egg laying. Extensive ringing and resightings of adults each year allowed us to identify the
 106 incubating parents individually. In the Temminck's Stint, we determined the sex of the incubator
 107 based on behavioural, morphological and molecular data (Lislevand *et al.* 2009; Pakanen *et al.*
 108 2010). We followed nest fate until hatching or clutch destruction, and searched for replacement
 109 clutches after clutch losses (e.g. Pakanen *et al.* 2014).

110 Secondly, we used unpublished nest data that were not collected during long-term population
 111 studies. These included Temminck's Stints from Tana and Varanger, Norway (ca. 70° 30' N, 28°
 112 26' E, O. Thorup, unpublished), Finnmark, Norway (the University Museum of Bergen nest record
 113 scheme, compiled by Ingvar Byrkjedal), the Varanger Peninsula, N Norway (approx. 70° 25' N, 31°
 114 00' E, T. Lislevand, unpublished), Finse, S Norway (T. Lislevand, unpublished) and from Taimyr
 115 (ca. 73° 32' - 73° 37' N, 80° 24' - 82° 20' E), Yakutia (ca. 72° 42' N, 131° 00') and Chukotka, Russia
 116 (ca. 62° 39' - 69° 42' N, 168° 37' E - 174° 42' W, P. Tomkovich, unpublished). Data on Southern
 117 Dunlin included observations from Öland (R. Ottvall, unpublished). Finally, we searched on Google
 118 scholar for publications reporting clutch sizes, using search words '*Calidris temminckii*', '*Calidris*
 119 '*alpina schinzii*' and 'clutch size', and also examined for clutch size data from faunistic reports from
 120 Russia.

121 We calculated supernormal clutches frequencies by pooling all nests in our analyses from all sites
 122 and calculated 95% confidence intervals for supernormal clutches frequencies as:

$$123 \pm 1.96 \sqrt{\frac{\text{frequency} (1 - \text{frequency})}{\text{sample size}}} \text{ (Brown } et al. 2001).$$

Seasonal timing of laying were estimated based on first egg laying dates. These were determined by floating the eggs in water, the number of eggs in nests found during egg laying, hatching date or chick age (Pakanen *et al.* 2016). Using data only from Bothnian Bay (Oulu and Kokkola), we describe the timing of supernormal clutches in relation to the distribution of laying dates from all the nests in the populations. We used year-centered laying dates for this comparison by subtracting the yearly mean laying date from the observed laying date of each nest. We report nest success (hatching at least one egg) and egg hatchability of supernormal clutches.

We looked on Google scholar for publications reporting clutch sizes for wader species in general using search words ‘shorebird’, ‘wader and ‘clutch size’, to compare with our results from Temminck’s Stint and Southern Dunlin. Here, we included information from publications that included specific data on each clutch size for at least ca. 200 clutches, to facilitate comparability with our sample sizes, but we did not attempt to make a full review of literature.

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137 3. Results

We found eight supernormal clutches among 1594 Temminck’s Stint nests (Table 1; Figure 1; Supplementary material) but only three supernormal clutches from 2766 Southern Dunlin nests (Table 2; Figure 2; Supplementary material). Five of the Temminck’s Stint clutches contained 5 eggs, the others 6, 7 and 8 eggs. The three Southern Dunlin clutches contained 5, 5 and 6 eggs. In all cases where the clutch size was 6-8 eggs, differences in egg sizes or egg pigmentation and rapid egg laying sequences suggested that eggs were laid by multiple females in one nest (Figures 1 & 2; Supplementary material). However, apart from one clutch where the clutch size was 5 eggs, there were either no clear visual differences between the eggs observed or none were recorded (Supplementary material). The overall supernormal clutch frequency was 0.0050 in the Temminck’s Stint and seemed to be lower in the Southern Dunlin (0.0011; Figure 3).

148 In the Temminck's Stint population at Bothnian Bay, there was a sex-bias in incubation patterns,
 149 with males incubating around 60% and females 40% of the nests. From the nests incubated by
 150 males, 4 were supernormal clutches (4/406), whereas from the nest incubated by females only 1 was
 151 a supernormal clutch (1/273). At Bothnian Bay, Temminck's Stint supernormal clutches were
 152 initiated during mid-laying season, while the Southern Dunlin nests were laid later in the season
 153 (Figure 4).

154 Eggs in three out of five supernormal Temminck's Stint nests hatched (two nests were predated),
 155 but hatchability of the eggs was low (nest 1. 2/5 eggs, nest 2. 4/7 eggs and nest 3. 2/5 eggs;
 156 Supplementary material). All three supernormal Southern Dunlin clutches were predated
 157 (Supplementary material).

158

159 4. Discussion

160 Supernormal clutches were exceedingly rare, but nonetheless were over four times more common in
 161 the Temminck's Stint (0.0050) than in the Southern Dunlin (0.0011). Among waders, Temminck's
 162 Stints show roughly an average frequency of these clutches, but Southern Dunlin were among the
 163 species with lowest reported supernormal clutch frequencies (Table 3).

164 Nests that included more than five eggs were probably laid by two females, as suggested by
 165 differences in egg size and pigmentation, and unusually quick laying sequences (see Figures 1 & 2
 166 and Supplementary material). The nests with five eggs either showed less clear differences between
 167 the eggs or this information was unavailable (see Figure 2 and Supplementary data). This suggests
 168 that all five eggs in those nests may have been laid by the same female (Grønstøl *et al.* 2006).

169 In waders, five egg clutches may also have been produced by egg dumping, a form of nest
 170 parasitism, resulting in a clutch size that can still be incubated and produce chicks (Sandercock *et*

171 *al.* 1997, Larsen *et al.* 2003, Lengyel *et al.* 2009, Colwell 2010). Intra-specific nest parasitism is a
 172 female's strategy to increase fitness with decisions being affected by ecological and individual
 173 conditions (Lyon & Eadie 2008). Causes behind this nest parasitism include the lack of space and as
 174 a best-of-a bad job response to nest predation during egg laying (Andersson 1984, Lank *et al.* 1989,
 175 Shaw & Hauber 2012), specific behavioral strategies (Lyon & Eadie 2008) and kin selection
 176 (Andersson & Waldeck 2007). While supernormal clutches are often taken as indicating nest
 177 parasitism (Yom-Tov 2001), genetic evidence is required for more definitive determination (Küpper
 178 *et al.* 2004, Grønstøl *et al.* 2006). In the Temminck's Stint, genetic evidence for eggs being laid by
 179 two females was found in 1 of 123 normal nests for which data from 3 or 4 eggs were available
 180 (Tracy *et al.*, unpublished data) and in 2 of 196 cases in the Southern Dunlin (Rönkä *et al.*,
 181 unpublished), i.e. higher rates than the supernormal nest frequencies found in this study. Thomas *et*
 182 *al.* (1989) describe a somewhat similar pattern for the Dotterel (*Charadrius morinellus*). Thus, even
 183 with clutches including confirmed mixed maternity, clutch size may be truncated to four eggs.
 184 Individuals in these species seem to show both determinate and indeterminate laying (Kennedy *et*
 185 *al.* 1990), and therefore, intra-specific nest parasitism rates cannot be fully assessed via supernormal
 186 clutches.

187 Supernormal clutches have been reported for many shorebird species, nearly always at low
 188 frequencies (Yom-Tov 2001; Table 3). Low frequencies have been taken as evidence suggesting
 189 that intra-specific nest parasitism is not a significant strategy used by shorebirds (Amat 1998). The
 190 small clutch size of shorebirds allows only a short window of opportunity for parasites to lay eggs
 191 in nests that are in the same developmental phase, in contrast to many ducks, for example, which
 192 lay large clutches and commonly show intra-specific nest parasitism (Andersson 1984, Colwell
 193 2010, Geffen & Yom-Tov 2001). Furthermore, incubating nests with more than five eggs may be
 194 difficult for shorebirds (Andersson 1978, Delehanty & Oring 1993), and often results in low
 195 hatchability, higher predation rates or increased rates of nest abandonment compared to normal

clutches (Amat 1998, Arnold 1999). In our data, three out of eight supernormal clutches hatched (38%), which is within observed variation for nest success (mean values: TS 26%, Rönkä *et al.* 2006; SD 46.5%, Pakanen *et al.* 2016). However, successful clutches produced only 2.67 chicks / clutch, which is lower than observed from clutch sizes 1 - 4 eggs (TS: 3.19, n = 112, Koivula *et al.* unpublished data; SD 3.57, n = 155, Pakanen *et al.* 2016). Other studies that did not find such evidence have suggested that problems such as lowered body condition and increased mortality might become evident after hatching (Larsen *et al.* 2003, Lengyel *et al.* 2009). It is therefore likely that clutches larger than 5 eggs result from behaviours other than parasitism, such as laying mistakes or polygyny.

The availability of nests for laying may be important for the occurrence of supernormal nests. If so, nest crypsis / concealment may influence the likelihood of laying in others nests. Species that have open nests, either on tundra or fields with low vegetation at the time of egg laying, e.g. Lapwing (*Vanellus vanellus*) and *Charadrius* plover species, have somewhat higher rates than those relying heavily on nest crypsis / concealment, such as the Southern Dunlin (Table 3). Given the variation in the occurrences of supernormal clutches across species, the contrast in frequency of supernormal clutches between the two focal species of this study, which breed in similar habitat, is interesting.

The supernormal Temminck's Stint clutches were consistently initiated during the peak of the laying season when the number of nests was highest. This is compatible with the hypothesis that higher nest availability could produce larger than normal clutches (Hötter 2000). For instance, the highest frequency of supernormal clutches in waders (Table 3) occurs in colonial-nesting Avocet species (*Recurvirostra* spp.) and Black-Winged Stilts (*Himantopus himantopus*) in which the frequency of supernormal clutches also increases with nest density. Occasionally, supernormal clutches can be very common among Black-Winged Stilts (0.12, n = 66; Tarasov *et al.* 2004).

219 In Temminck's stints, nest availability, and thus the likelihood of super-normal clutches, might
 220 increase for at least two reasons. First, the species is sometimes found to breed in rather dense semi-
 221 colonies (e.g. Hildén 1979; own observations). Second, displaying males often attract several
 222 females to their territories, which may make it easier to find a suitable nest site for females laying
 223 both partial and complete clutches. Clutches with multiple eggs laid by two females (clutch size >
 224 5), can have resulted from polygamy, where two females mistakenly laid eggs in the same nest (e.g.
 225 Colwell 2010). If so, this apparent 'parasitism' would be an epiphenomenon, a non-adaptive
 226 consequence of other behavior (Lyon & Eadie 2008). When the male has sired all young in the
 227 clutch, this behavior is termed quasi-parasitism (Alves & Bryant 1998), which has been found in
 228 two wader species (Blomqvist *et al.* 2002, Küpper *et al.* 2004). Whether or not supernormal
 229 clutches reflect laying errors or quasi-parasitism, this is easily conceivable in the sequentially
 230 polygamous Temminck's Stint in which the female's strategy is to lay multiple clutches (up to
 231 three) that are uniparentally incubated by the males or the laying female (Hildén 1975, Breiehagen
 232 1989, Thomson *et al.* 2014). The strategy of the male is also to copulate with multiple partners.
 233 Males often display on their territories at or close to nest scrapes (future nest) or at the actual nest,
 234 where copulations also often occur. The male may be successful in copulating with more than one
 235 female which lays a clutch for the male to incubate. Temminck's Stints also show relatively high
 236 rates of extra-pair paternity for a small shorebird (Thomson *et al.* 2014), and it is possible that
 237 males have extra-pair copulations with females, which subsequently lay eggs in his nest (Küpper *et*
 238 *al.* 2004). The apparently lower frequency of female-incubated supernormal clutches fits this line of
 239 reasoning, as the female may lay her own nest without the presence of the siring male (Breiehagen
 240 1989).

241 The Southern Dunlin contrasts with Temminck's Stints in being essentially genetically
 242 monogamous (Blomqvist *et al.*, unpubl.) and in that pairs spend the egg laying period in close
 243 proximity to each other (own observations). Interestingly, the three Southern Dunlin supernormal

244 clutches were replacement nests late in the season. After losing their first nest, Southern Dunlin
 245 males may court multiple females if their original mate has departed from the breeding grounds
 246 (own observations), which could occasionally result in situations similar to that described above for
 247 the Temminck's Stints.

248 We have shown that supernormal clutches occur at low frequencies in these two species, but seem
 249 occur more frequently in Temminck's Stints than in Southern Dunlins. We hypothesize that a
 250 mating system that involves simultaneous courtship of multiple partners or high densities of birds
 251 facilitates the occasional occurrence of supernormal clutches in cryptic nesting species.

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257 References

- 258 Alves M.A.S. & Bryant D.M. 1998. Brood parasitism in the sand martin, *Riparia riparia*: evidence
 259 for two parasitic strategies in a colonial passerine. *Anim. Behav.* 56: 1323-1331.
- 260 Amat J.A. 1998. Mixed clutches in shorebirds nests: Why are they so uncommon? *Wader Study*
 261 *Group Bull.* 85: 55-59.
- 262 Andersson M. 1978. Optimal egg shape in waders. *Ornis Fenn.* 55: 105-109.
- 263 Andersson M. 1984. Brood parasitism within species. In: Barnard E.J. (ed.) *Producers and*
 264 *scroungers: strategies for exploitation and parasitism*: 195-228. Croom Helm, London.
- 265 Andersson M. & Waldeck P. 2007. Host-parasite kinship in a female-philopatric bird population:
 266 evidence from relatedness trend analysis. *Mol. Ecol.* 16: 2797-2806.
- 267 Arnold T.W. 1999. What limits clutch size in waders? *J. Avian Biol.* 30: 216—220.

- Blomqvist D., Andersson M., Küpper C., Cuthill I.C., Kis J., Lanctot RB, Sandercock BK, Székely T, Wallander J & Kempenaers B. 2002. Genetic similarity between mates and extra-pair parentage in three species of shorebirds. *Nature* 419: 613-615.
- Blomqvist D., Pauliny A., Larsson M. & Flodin L.-Å. 2010. Trapped in the extinction vortex? Strong genetic effects in a declining vertebrate population. *BMC Evol Biol* 10: 33.
- Breihagen T. 1989. Nesting biology and mating system in an alpine population of Temminck's Stint *Calidris temminckii*. *Ibis* 131: 389-402.
- Brown L.D, Cai, T.T. & DasGupta, A. 2001. Interval estimation for a binomial proportion. *Statistical Science* 16: 101–133.
- Christian N. & Hancock M.H. 2009. A 25-year study of breeding Greenshanks. *British Birds* 102: 203-210.
- Colwell M.A. 1986. Intraspecific brood parasitism in three species of prairie-breeding shorebirds. *Wilson Bull.* 98: 473-475.
- Colwell M.A. 2010. *Shorebird Ecology, Conservation, and Management*. University of California Press, Berkeley.
- Conover M.R. 1984. Occurrence of super-normal clutches in the Laridae. *Wilson Bull.* 96: 249-267.
- Delehanty D. & Oring L. 1993. Effect of clutch size on incubation persistence in male Wilson's Phalaropes (*Phalaropus tricolor*). *Auk* 110: 521-528.
- Dorogoi I.V. 1988. Materials on biology of waders in the lower Chukochya River (north-eastern Yakutia). *Bulletin of Moscow Soc. of Naturalists. Biol. Section.* 93: 61-67. [In Russian]
- Estafiev A.A. 1991. *Fauna and ecology of waders of Bolshezemelskaya Tundra and Yugorsky Peninsula*. Leningrad, "Nauka" Publishers. 145 p. [In Russian]
- Geffen E. & Yom-Tov Y. 2001. Factors affecting the rates of intraspecific nest parasitism among Anseriformes and Galliformes. *Anim. Behav.* 62: 1027-1038.

- 292 Giroux, J.-F. 1985. Nest-sites and superclutches of American Avocets on artificial islands. Can. J.
 293 Zool. 63: 1302-1305.
- 294 Gladkov N.A. 1962. Materials on birds of Vorkuta vicinity (eastern Bolshezemelskaya Tundra).
 295 Ornithologia 4: 15-28. [In Russian]
- 296 Grønstøl G., Blomqvist D. & Wagner R.H. 2006. The importance of genetic evidence for
 297 identifying intra-specific brood parasitism. J. Avian Biol. 37: 197-199.
- 298 Heldt R. 1966. Zur Brutbiologie des Alpenstrandläufers *Calidris alpina schinzii*. Corax 1: 173-188.
- 299 Hildén O. 1975. Breeding system of Temminck's stints *Calidris temminckii*. Ornis Fenn. 52: 118-
 300 144.
- 301 Hildén O. 1979. Territoriality and site tenacity of Temminck's stint *Calidris temminckii*. Ornis
 302 Fenn. 56: 56-74.
- 303 Hamas M.J. & Graul W.D. 1985. A four-egg clutch of the Mountain Plover. Wilson Bull. 97: 388-
 304 389.
- 305 Hötter H. 2000. Conspecific nest parasitism in the Pied Avocet *Recurvirostra avosetta*. Ibis 142:
 306 280-288.
- 307 Jönsson P.E. 1988. Ecology of the southern dunlin *Calidris alpina schinzii*. Unpublished Ph.D.
 308 Thesis, University of Lund.
- 309 Kalejta-Summers B. & Summers R.W. 2015. A Wood Sandpiper *Tringa glareola* nest with six
 310 eggs. Wader Study 122: 255–258.
- 311 Kennedy E.D. 1990. Determinate and indeterminate egg laying patterns: a review. Condor 93:
 312 106-124.
- 313 Krechmar A.V. 1966. The birds of Western Taimyr. Pp. 185-312 in: A.I. Ivanov (ed.). Archives of
 314 Zoological Institute, Acad. Sci. of the USSR. Vol. 39. Moscow-Leningrad, "Nauka". [In
 315 Russian]

- 316 Kondratyev A.Y. 1982. Biology of waders in tundras of North-Eastern Asia. Moscow, "Nauka"
 317 Publishers. 192 p. [In Russian]
- 318 Kokhanov V.D. 1973. Materials on the biology of the Temminck's stint in Kandalaksha Bay in the
 319 White Sea. In; Flint VE (ed.) Fauna and Ecology of Waders Vol 1: pp 66-71. Moscow Society
 320 of Naturalists, Moscow. ". [In Russian]
- 321 Küpper C., Kis J, Kosztolanyi A., Székely T., Cuthill I.C. & Blomqvist D. 2004. Genetic mating
 322 system and timing of extra-pair fertilizations in the Kentish plover. Behav. Ecol. Sociobiol.
 323 57: 32–39.
- 324 Labutin Yu.V., Germogenov N.I. & Pozdnyakov V.I. 1988. Birds of nearwater landscapes of the
 325 Lower Lena River valley. Novosibirsk, "Nauka" Publishers. 193 p. [In Russian]
- 326 Lack D. 1947. The significance of clutch size. Ibis 89: 302–352.
- 327 Lank D.B., Cooch E.G., Rockwell R.F. & Cooke F. 1989. Environmental and demographic
 328 correlates of intraspecific nest parasitism in lesser snow geese *Chen caerulescens*
 329 *caerulescens*. J. Anim. Ecol. 58: 29–45.
- 330 Larionov G.P., Degtyaryov V.G. & Larionov A.G. 1991. Birds of the area between the Lena and
 331 Amga Rivers. Novosibirsk, "Nauka" Publishers. 189 p. [In Russian]
- 332 Larsen V. A., Lislevand T. & Byrkjedal I. 2003. Is clutch size limited by incubation ability in
 333 northern lapwings? J. Anim. Ecol. 72: 784–792.
- 334 Lengyel S., Kiss B. & Tracy C.R. 2009. Clutch size determination in shorebirds: revisiting
 335 incubation limitation in the pied avocet (*Recurvirostra avosetta*). J. Anim. Ecol. 78: 396-405.
- 336 Lislevand T., Marthinsen G. & Lifjeld J. 2009. Sex differences in body size and body condition in
 337 breeding Temminck's stints *Calidris temminckii*. J. Ornithol. 150: 299–302.
- 338 Lyon B.E. & Eadie J. McA. 2008. Conspecific brood parasitism in birds: a life history perspective.
 339 Annu. Rev. Ecol. Evol. Syst. 39: 343-363.
- 340 Maclean G.L. 1972. Clutch size and evolution in the Charadrii. Auk 89: 299–324.

- 341 Mineyev Yu.N. & Mineyev O.Yu. 2012. Birds of the Bolshezemelskaya Tundra and the Yugorsky
 342 Peninsula. St. Petersburg, "Nauka" Publishers. 384 p. [In Russian with English summary]
- 343 Mineyev Yu.N. & Mineyev O.Yu. 2009. Birds of the Malozemelskaya Tundra and the Pechora
 344 River Delta. St. Petersburg, "Nauka" Publishers. 264 p. [In Russian with English summary]
- 345 Monaghan P. & Nager R. 1997. Why don't birds lay more eggs? TREE 12:270-274.
- 346 Morozov V.V. & Syroechkovsky E.E. Jr. 2004. Materials to the knowledge of the bird fauna of
 347 Kolguev Island. Ornithologia, Vol. 31: 9-50. [In Russian with English Summary]
- 348 Mundahl J.T., Johnson O.L. & Johnson M.L. 1981. Observations at a twenty-egg Killdeer nest.
 349 Condor 83:180-182.
- 350 Nethersole-Thompson, D. & Nethersole-Thompson M. 1986. Waders. Their breeding, haunts and
 351 watchers. Poyser, Calton.
- 352 Nikolayev V.V., Kondratyev A.Ya. & Koshelev A.I. 2015. Habitat distribution and breeding of
 353 birds in tundras of the Chaun Lowland (Western Chukotka). Russ. J. Ornithol. 24, express-
 354 issue 1205: 3807-3822. [In Russian]
- 355 Nol E., Blanken M.S. & Flynn L. 1997. Sources of variation in clutch size, egg size and clutch
 356 completion dates of Semipalmated Plovers in Churchill, Manitoba. Condor 99: 389-396.
- 357 Oring L., Lank D. & Maxson S. 1983. Population studies of the polyandrous Spotted Sandpiper.
 358 Auk 100: 272-285.
- 359 Pakanen V.-M., Rönkä A., Belda E.-J., Luukkonen A., Kvist L. & Koivula K. 2010. Impact of
 360 dispersal status on estimates of local population growth rates in a Temminck's Stint (*Calidris*
 361 *temminckii*) population. Oikos 119: 1493-1503.
- 362 Pakanen V.-M., Hildén O., Rönkä A., Belda E.-J., Luukkonen A., Kvist L. & Koivula K. 2011.
 363 Breeding dispersal strategies following reproductive failure explain low apparent survival of
 364 immigrant Temminck's stints. Oikos 120: 615-622.

- 365 Pakanen V.-M., Rönkä N., Thomson R.L. & Koivula K. 2014. Informed renesting decisions: the
 366 effect of nest predation risk. *Oecologia* 174: 1159–1167.
- 367 Pakanen V.-M. & Thorup O. 2016. Apparent adult survival of the critically endangered Baltic
 368 Dunlin (*Calidris alpina schinzii*) during a period of strong population decline. *Bird Study* 63:
 369 293–302.
- 370 Pakanen V.-M., Aikio S., Luukkonen A. & Koivula K. 2016. Grazed wet meadows are sink habitats
 371 for the southern dunlin (*Calidris alpina schinzii*) due to nest trampling by cattle. *Ecol Evol.* 6:
 372 7176–7187.
- 373 Pakanen V.-M., Koivula K., Flodin L.-Å., Grissot A., Hagstedt R., Larsson M., Pauliny A., Rönkä
 374 N. & Blomqvist D. 2017. Between-patch natal dispersal declines with increasing natal patch
 375 size and distance to other patches in the endangered Southern Dunlin *Calidris alpina schinzii*.
 376 *Ibis* 159: 611–622.
- 377 Reynolds J.D. 1987. Mating system and nesting biology of the red-necked phalarope *Phalaropus*
 378 *lobatus*: what constrains polyandry? *Ibis* 129: 225–242.
- 379 Ryabitsev V.K. 2007. The Temminck's Stint *Calidris temminckii* in Yamal. *Russ. J. Ornithol.* 16,
 380 express-issue 376: 1191-1208. [In Russian]
- 381 Rönkä A., Koivula K., Ojanen M., Pakanen V.-M., Pohjoismäki M., Rannikko K. & Rauhala P.
 382 2006. Increased nest predation in a declining and threatened Temminck's stint (*Calidris*
 383 *temminckii*) population. *Ibis* 148: 55–65
- 384 Sandercock B.K. 1997. Incubation capacity and clutch size determination in two calidrine
 385 sandpipers: a test of the four-egg threshold. *Oecologia* 110: 50–59.
- 386 Shaw R.C. & Hauber M.E. 2012. Linking nest predation with brood parasitism in captive zebra
 387 finches: A multi-pair study. *J. Ethol.* 30: 255-262.
- 388 Soikkeli M. 1970. Mortality and reproductive rates in a Finnish population of Dunlin *Calidris*
 389 *alpina*. *Ornis Fenn.* 47: 149–158.

- 390 Spangenberg E.P. & Leonovich V.V. 1960. Birds of the north-eastern coast of the White Sea. Pp.
 391 213-336 in G.A. Novikov (ed.). Archives of the Kandalaksha State Nature Reserve, issue 2.
 392 Murmansk: Murmansk Book Publishers. [In Russian]
- 393 Summers R.W. & Whitfield D.P. 2004. A Purple Sandpiper *Calidris maritima* nest with seven eggs.
 394 Wader Study Group Bull. 103: 75–76.
- 395 Tarasov V.V. 2004. On the distribution and biology of the Black-winged Stilt *Himantopus*
 396 *himantopus* in the Eastern Urals forest-steppe. – In V.K. Ryabitsev & L.V. Korshikov (eds.).
 397 Waders of the Eastern Europe and Northern Asia: Studies and Conservation. Ekaterinburg:
 398 The Urals University Publ. 194-196. [in Russian]
- 399 Thomas C., Thompson D. & Galbraith H. 1989. Physiognomic variation in Dotterel *Charadrius*
 400 *morinellus* clutches. Ornis Scandinavica 20: 145-150.
- 401 Thomson R.L., Pakanen V.-M., Tracy D., Rönkä A., Lank D., Kvist L. & Koivula K. 2014.
 402 Providing parental care entails variable mating opportunity costs for male Temminck's stints.
 403 Behav. Ecol. Sociobiol. 68: 1261–1272.
- 404 Thorup O. 1998. The breeding birds on Tipperne 1928 – 1992. Dansk Orn. Foren. Tidsskr. 92: 1-
 405 192. [In Danish with English summary]
- 406 Tomkovich P.S. & Fokin S.Yu. 1983. On the ecology of the Temminck's Stint in north-east Siberia.
 407 Ornithologia 18: 40-56. [In Russian with English summary]
- 408 Tinarelli R. 1991. Habitat and breeding performance of the Black-winged Stilt *Himantopus*
 409 *himantopus* in Italy. Wader Study Group Bull. 65: 58-62.
- 410 Wallander J. & Andersson M. 2002. Clutch size limitation in waders: experimental test in redshank
 411 *Tringa totanus*. Oecologia 130: 391-395.
- 412 Wallander J. & Andersson M. 2003. Reproductive Tactics of the Ringed Plover *Charadrius*
 413 *hiaticula*. Journal of Avian Biology 34: 259-266.

- 414 Walters J.R. 1984. The evolution of parental behavior and clutch size in shorebirds. Behavior of
 415 Marine Animals. Shorebirds: Breeding Behavior and Populations (eds J. Burger & B.L. Olla),
 416 pp. 243–287. Plenum Press, New York.
- 417 Weiser E.L., Brown S.C., Lanctot R.B., Gates H.R., Abraham K.F., Bentzen R.L., Bêty J ,
 418 Boldenow M.L., Brook R.W., Donnelly T.F., English W.B., Flemming S.A., Franks S.E.,
 419 Gilchrist H.G., Giroux M., Johnson A., Kennedy L.V., Koloski L., Kwon E., Lamarre J., Lank
 420 D.B., Lecomte N., Liebezeit J.R., McKinnon L., Nol E., Perz J., Rausch J., Robards M.,
 421 Saalfeld S.T., Senner N.R., Smith P.A., Soloviev M., Solovyeva D., Ward D.H., Woodard
 422 P.F. & Sandercock B.K. 2018. Life-history tradeoffs revealed by seasonal declines in
 423 reproductive traits of Arctic-breeding shorebirds. J Avian Biology 49: jav-01531.
- 424 Wojczulanis-Jakubas K. & Jakubas D. 2010. Supernormal clutch incubated by Dovekie *Alle alle*
 425 Waterbirds 33: 411-414.
- 426 Yogev A, Ar A. & Yom-Tov Y. 1996. Determination of Clutch Size and the Breeding Biology of
 427 the Spur-Winged Plover (*Vanellus spinosus*) in Israel. Auk 113: 68-73.
- 428 Yom-Tov Y. 2001. An updated list and some comments on the occurrence of intraspecific nest
 429 parasitism in birds. Ibis 143: 133–143.
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439 Table 1. Frequency of supernormal clutches in different Temminck's Stint populations. Data
 440 source: 1 = colour ringing study, 2 = sampling not including colour ringing, 3 = data from
 441 literature (see methods).

Population	Years	Super clutches	n	Freq	Source data	Ref
Kokkola, Bothnian Bay, Finland	1963-1970	2	185	0.0108	1	1.
Oulu, Bothnian Bay, Finland	1994-2012	3	457	0.0066	1	2.
Enontekiö, Finland	2003-2005	0	80	0.0000	1	3.
Finse, Norway	1980-1982	0	63	0.0000	1	4.
Finse, Norway	2010-2012	0	58	0.0000	2	5.
Varanger, Norway	2003-2015	0	84	0.0000	2	5.
Finnmark, Norway	1932-2017	0	73	0.0000	2	6.
Tana and Varanger, Norway	1984	0	22	0.0000	2	7.
Kandalaksha Bay, Russia	1968-1972	0	56	0.0000	3	8.
Taimyr, Russia	1982-1984	0	6	0.0000	2	9.
Yakutia, Russia	1977	0	15	0.0000	2	9.
Chukotka, Russia	1979-2017	0	52	0.0000	2	9.
Kanin Peninsula, Russia	-	0	22	0.0000	3	10.
Chukotka and NE Yakutia, Russia	1972-1980	1	38	0.0263	3	22.
Kolguev Island ETC, Russia	1994-1995	1	11	0.0909	3	11.
Malozemetskaya Tundra and the Pechora River Delta, Russia	1976-2005	0	57	0.0000	3	12.
More-Yu River basin, Russia	1976-1979	0	29	0.0000	3	13.
Bolshezemelskaya Tundra, Russia	1958	0	7	0.0000	3	14.
Bolshezemelskaya Tundra and the Yugorsky Peninsula, Russia	1972-2011	0	45	0.0000	3	15.
Yamal Peninsula, Russia	1970-1995	1	173	0.0058	3	16.
Western Taimyr, Russia	1960-1964	0	19	0.0000	3	17.
Besyuke River area at the Lower Lena River, Russia	1983-1985	0	6	0.0000	3	18.
Sytygan-Tala Bay, Yakutia, Russia	1977	0	17	0.0000	3	19.
Lena and Amga River, Russia	1978-1983	0	7	0.0000	3	20.
the lower Chukochya River , Russia	1983-1984	0	5	0.0000	3	21.
the Chaun Lowland , Russia	1978-1979	0	7	0.0000	3	23.
Total		8	1594	0.0050		

442 1. Hildén 1979; 2. Pakanen *et al.* 2011; 3. Diane Tracy *et al.* unpublished; 4. Breiehagen 1989; 5.
 443 Lislevand, unpublished; 6. the University Museum of Bergen (compiled by Ingvar Byrkjedal); 7.
 444 Ole Thorup, unpublished; 8. Kokhanov 1973; 9. Pavel Tomkovich, unpublished; 10. Spangenberg
 445 & Leonovich 1960; 11. Kondratyev 1982.; 12. Morozov & Syroechkovsky 2004; 13. Mineyev &
 446 Mineyev. 2009; 14. Estafiev 1991; 15. Gladkov 1962; 16. Mineyev & Mineyev 2012; 17. Ryabitsev
 447 2007; 18. Krechmar 1966; 19. Labutin *et al.* 1988; 20. Tomkovich & Fokin 1983; 21. Larionov *et*
 448 *al.* 1991; 22. Dorogoi 1988; 23. Nikolayev *et al.* 2015

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451 Table 2. Frequency of supernormal clutches in different Southern Dunlin populations. Data source:
 452 1 = colour ringing study, 2 = sampling not including colour ringing, 3 = data from literature
 453 (see methods).

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Population	Years	Super clutches	Clutches	Frequency	Source data	Refs
Pori, Finland	1962-1969	0	225	0.0000	1	1.
Pori, Finland	1992-2016	0	254	0.0000	1	2.
Bothnian Bay, Finland	2002-2017	3	533	0.0056	1	3.
Northern Germany	1959-1964	0	295	0.0000	3	4.
Southern Sweden	1981-1986	0	163	0.0000	1	5.
Foteviken, Sweden	2007-2017	0	63	0.0000	1	6.
Öland, Sweden	2003-2017	0	40	0.0000	2	7.
Tipperne, Denmark	1985-2017	0	642	0.0000	1	8.
West coast, Sweden	1987-2016	0	468	0.0000	1	9.
West coast, Estonia	2010-2016	0	59	0.0000	1	10.
Sutherland, UK		0	24	0.0000	3	11.
Total		3	2766	0.0011		

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456 1. Soikkeli 1970; 2. Kimmo Nuotio unpublished. 3. Pakanen *et al.* 2017; 4. Heldt 1966; 5. Jönsson
 457 1988; 6. Peter Olsson, unpublished; 7. Richard Ottvall, unpublished; 8. Pakanen & Thorup 2016; 9.
 458 Blomqvist *et al.* 2010; 10. Hannes Pehlak *et al.*, unpublished. 11. Nethersole-Thompson &
 459 Nethersole-Thompson 1986.

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Table 3. Published frequencies of supernormal clutches and intra-specific parasitism in different wader species. Studies reporting intra-specific parasitism are denoted by an asterisk.

Species	Freq	n	Ref
<i>Recurvirostra americana</i>	0.1540	383	1.
<i>Himantopus himantopus</i>	0.069 ^a	984	2.
<i>Recurvirostra avosetta</i>	0.0330*	3182	3.
<i>Vanellus vanellus</i>	0.0137	877	4.
<i>Charadrius alexandrinus</i>	0.010*	883	5.
<i>Phalaropus lobatus</i>	0.0082	243	6.
<i>Charadrius hiaticula</i>	0.0092	436	4.
<i>Tringa totanus</i>	0.0065	1986	4.
<i>Gallinago gallinago</i>	0.0064	467	4.
<i>Arenaria interpres</i>	0.0057	523	4.
<i>Calidris pugnax</i>	0.0051	396	7.
<i>Calidris temminckii</i>	0.0050	1594	8.
<i>Charadrius montanus</i>	0.0050	200	9.
<i>Phalaropus tricolor</i>	0.0040	232	10.
<i>Numenius arquata</i>	0.0040	506	4.
<i>Tringa nebularia</i>	0.0046	435	4.
<i>Calidris mauri</i>	0.0044	224	11.
<i>Actitis macularia</i>	0.0032	317	12.
21 shorebirds species	0.0030	ca. 7827	13.
<i>Charadrius alexandrinus</i>	0.0030	1291	14.
<i>Pluvialis apricaria</i>	0.0025	403	4.
<i>Calidris alpina schinzii</i>	0.0011	2766	8.
<i>Calidris pusilla</i>	0.0000	205	11.
<i>Charadrius semipalmatus</i>	0.0000	199	15.
<i>Vanellus spinosus</i>	0.0000	632	16.

References: 1. Giroux 1985; 2. Tinarelli 1991; 3. Hötter 2000; 4. Nethersole-Thompson & Nethersole-Thompson 1986; 5. Amat 1998; 6. Reynolds 1987; 7 Thorup 1998; 8. this study; 9. Hamas & Graul 1985; 10. Colwell 1986; 11. Sandercock *et al.* 1999; 12. Oring *et al.* 1983; 13. Weiser *et al.* 2018; 14. Küpper *et al.* 2004; 15. Nol *et al.* 1997; 16. Yogev *et al.* 1996. ^a For clutches larger than five eggs.

498 Figure 1. Temminck's Stint nest (nest 5. in Table S1) with seven eggs (top) and eight eggs the next
499 day (bottom). Photos: Ville Suorsa.

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503 Figure 2. Southern Dunlin nests with six eggs (top: nest 1. in Table S2) and five eggs (middle: nest
504 2. in Table S2, bottom: nest 3. in Table S2). Photos: Veli-Matti Pakanen.

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506 Figure 3. Supernormal clutch frequencies and their 95% confidence intervals in Temminck's Stint
507 and Southern Dunlin nests.

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517 Figure 4. Timing of laying of supernormal clutches in relation to timing of all nests in (a)
 518 Temminck's Stint and (b) Southern Dunlin populations at Bothnian Bay, Finland. The laying date
 519 of each supernormal clutch is indicated by a black arrow.

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527 Supplementary material to
 528 Pakanen V-M, Blomqvist D, Breiehagen T, Flodin L-Å, Hildén O, Lank DB, Larsson M, Lislevand
 529 T, Nuotio K, Olsson P, Ottvall R, Pehlak H, Pauliny A, Rönkä A, Rönkä N, Schamel D, Soikkeli
 530 M, Thomson RL, Tracy D, Tomkovich P, Thorup O and Koivula K. Low frequencies of
 531 supernormal clutches in the Southern Dunlin and the Temminck's Stint
 532
 533 We found altogether 11 supernormal clutches for Temminck's Stints
 534 Table S1. Summary of supernormal clutches found in the Temminck's stint.

#	Eggs	Site	Date	Included	Reference
1.	5 eggs	Kokkola, Finland	12 June 1964	yes	This study
2.	7 eggs	Kokkola, Finland	6 June 1968	yes	This study
3.	5 eggs	Oulu, Finland	22 June 2000	yes	This study
4.	5 eggs	Siikajoki, Finland	9 June 2005	yes	This study
5.	8 eggs	Oulu, Finland	6 June 2002	yes	This study
6.	5 eggs	Kolguev Island, Russia	12 June 1995	yes	Morozov & Syroechkovsky 2004
7.	5 eggs	NE Yakutia, Russia	18 June 1979	yes	Kondratyev 1982
8.	6 eggs	Yamal Peninsula, Russia	3 July 1988	yes	Ryabitsev 2007
9.	7 eggs	Lapland, Sweden		no	Nethersole-Thompson & Nethersole-Thompson (1986)
10.	7 eggs	Kanin Peninsula, Russia	29 June 1990	no	pers. obs. Pavel Tomkovich
11.	7 eggs	Kanin Peninsula, Russia	13 June 1991	no	pers. obs. Pavel Tomkovich

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538 Long term studies: five nests with more than four eggs

539 1) In Kokkola, a nest with one egg was found on 6 June 1964. On June 7, there were 2 eggs, but on
540 12 June there were 5 eggs. All eggs seemed to be of similar colour. The female incubated from 13
541 June until 2 July when two eggs hatched successfully.

542 2) Another nest in Kokkola was found on 4 June 1968 with two eggs at 7:00 in the morning. At
543 18:10, there were 3 eggs. On 5 June, there were 5 eggs and the next day there were 6 eggs at 19:15
544 and 7 eggs at 22:45. The male started to incubate the nest on June 7. Four chicks hatched on 27
545 June.

546 3) In Oulu, one nest with five eggs was found on 22 June 2000. It was incubated by a male. Only
547 two eggs hatched on 30 June.

548 4) Another male incubated nest with five eggs was found in Tauvo, Siikajoki on 9 June 2005. It was
549 found depredated on 23 June.

550 5) On 4 June 2002, a nest with six eggs was found in Oulu. The nest had seven eggs on 5 June (Fig.
551 1) when we caught a laying female at the nest (female weighed > 30 grams). The following day (6
552 June) the nest had already eight eggs (Fig. 1). The egg pigmentation suggests that two females laid
553 two clutches of four eggs in the same nest. We did not manage to identify the incubating bird before
554 the nest was depredated on 9 June. However, the timing of the nest suggests that it was a male-
555 incubated nest (Pakanen *et al.* unpublished data).

556 Literature. We found information on six supernormal clutches from literature. Three supernormal
557 clutches have been preserved among 52 nests in the Zoological Museum of Moscow State
558 University (pers. obs. Pavel Tomkovich). Two of these had seven eggs. Both of them were fresh
559 and collected at the Kanin Peninsula near Shoyna Village on 29 June 1990 and 13 June 1991 with a
560 label of one of the clutches saying that the eggs were laid by two females, which was likely based

561 on a notable difference in colouring and mass between 4 and 3 eggs of that clutch. However, only
562 one of these three supernormal clutches in the museum nests was part of a published study where
563 the number of sampled nests was included (Kolguev Island ETC, Russia, 12 June 1995; Morozov &
564 Syroechkovsky 2004). This nest contained five eggs.

565 Another study from Chukotka and NE Yakutia, Russia reported one supernormal clutch with five
566 eggs (Kondratyev 1982) along with other nests. The nest with five eggs was found in willows of the
567 Kon'kovaya River floodplain [NE Yakutia - PT] on 18 June 1979.

568 Ryabitsev (2007) reports clutch size data for 173 Temminck's Stint nests from the southern, central
569 and northern parts of the Yamal Peninsula. The data included one nest with 6 eggs which was
570 found near Khanovey Field Station on 3 July 1988.

571 Nethersole-Thompson & Nethersole-Thompson (1986) reported a clutch in Swedish Lapland
572 containing seven eggs laid by two females (found by J. B. and S Bottomley). However, information
573 on the number of sampled nests is lacking.

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582 We found altogether five supernormal clutches for the Southern Dunlin.

583 Table S2. Summary of supernormal clutches found in the Southern Dunlin.

#	eggs	Site	Date	Included	Reference
1.	6 eggs	Lumijoki, Finland	16 June 2009	yes	This study
2.	5 eggs	Hailuoto, Finland	30 May 2016	yes	This study
3.	5 eggs	Hailuoto, Finland	3 June 2018	yes	This study
4.	6 eggs	South Uist, Scotland		no	Nethersole-Thompson & Nethersole-Thompson (1986)
5.	6 eggs	South Uist, Scotland		no	Nethersole-Thompson & Nethersole-Thompson (1986)

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585 Long term studies: We found three Southern Dunlin nests with more than four eggs.

586 1) On 16 June 2009, we found a nest with six eggs at Pitkänokka, Lumijoki (upper Fig. 2). The nest
 587 was found during early incubation. It was a replacement nest laid after a storm and rising sea level
 588 destroyed the nests. Egg pigmentation clearly shows that two females had laid three egg clutches in
 589 the same nest. The nest was depredated in late June / early July.

590 2) On May 30 2016, we found a nest with five eggs at Tömpä, Hailuoto (middle Fig. 2). One egg
 591 was darker than the others. The nest failed just before hatching 19 June.

592 3) On June 3 2018, we found a nest with five eggs at Tömpä, Hailuoto (bottom Fig. 2). All of the
 593 eggs seemed similar in colour. The nest was incubated but found predated by 7 June.

594 Literature. Nethersole-Thompson & Nethersole-Thompson (1986) reported two nests with six eggs
 595 from South Uist in Scotland, but information on the number of sampled nests is lacking.

596 References

- 597 Kondratyev A.Y. 1982. Biology of waders in tundras of North-Eastern Asia. Moscow, "Nauka"
598 Publishers. 192 p. [In Russian]
- 599 Morozov V.V. & Syroechkovsky, E.E. Jr. 2004. Materials to the knowledge of the bird fauna of
600 Kolguev Island. Ornithologia, Vol. 31: 9-50. [In Russian with English Summary]
- 601 Ryabitsev V.K. 2007. The Temminck's Stint *Calidris temminckii* in Yamal. Russ. J. Ornithol. 16,
602 express-issue 376: 1191-1208. [In Russian]
- 603 Nethersole-Thompson D. & Nethersole-Thompson M. 1986. Waders. Their breeding, haunts and
604 watchers. Poyser, Calton.
- 605