Seaweed provisioning behaviour confers thermal benefit for nesting Australasian gannets
(Morus serrator)

J.L. Matthews¹,², S.M.H. Ismar¹,³ & M.E. Hauber¹
(¹ School of Biological Sciences, University of Auckland, Private Bag 92019, Auckland, New Zealand; ² Department of Biology and Biochemistry, University of Bath, Bath, UK)

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Summary
Despite prolonged and obligate biparental care for a single offspring in the Australasian gannet Morus serrator, several reproductive behaviours are presumed to be sex specific and might indicate sexual dimorphism in mating and parental effort in this broadly monomorphic seabird. For instance, the delivery of seaweed as a nesting material has been typically considered a male specific trait. We assessed this assumption and determined whether the potential role of this behaviour is to serve as a nuptial trait preceding copulation or to impart a thermal benefit for incubation. First, as predicted, all arriving individuals at the colony that mated following seaweed delivery assumed the top copulatory position, which is consistent with male behaviour in this species. In comparison, the likelihood of birds without seaweed copulating in top position upon arrival at the nest site was approx. 50%, indicating an even mix of the sexes. However, the sex of those individuals in our sample that did not copulate during our observations remains unresolved. Second, seaweed delivery was not related to copulation following arrival, as individuals arriving with seaweed in our sample had a lower probability of mating than did individuals arriving without seaweed. Third, to determine if seaweed provides thermoregulatory benefits to alleviate the physiological costs of incubation, the foot temperatures of incubating and non-incubating individuals and temperatures of nests with or without seaweed were recorded. Temperatures of the foot-webbings during incubation were significantly higher above ambient temperatures than those of non-incubating gannets at the colony. Nests that contained seaweed were significantly warmer at sunrise than those without seaweed. There was no consistent difference between the temperatures of nesting material in the evenings alone, with a large variance of evening nest temperatures. These correlative data are consistent with male specificity and thermoregulatory benefits associated with seaweed delivery in M. serrator, implying that further experimental work on known-sexed birds...
Introduction

Many seabird species are well known for their prolonged breeding periods, costly parental investment into one or few offspring and obligate biparental care required for successful reproduction (Brooke, 2004). Despite the critical and shared contribution to reproductive investment by both sexes, several aspects of the breeding behaviours of many seabirds are sex dimorphic, including initial nest site establishment and defence by males (Dearborn, 2001). What are the evolutionary benefits and physiological consequences of sex differences in reproductive behaviours in these otherwise obligately biparental species?

For example, with the onset of the breeding season Australasian gannets, Morus serrator (Gray) can be observed carrying seaweed to their nest sites (Nelson, 1978). The corresponding behaviour in the closely related Atlantic gannet, M. bassanus, is attributed to the male sex and reported to be closely linked with copulation propensity (Nelson, 2002). The fitness relevance of this behaviour, its sex specificity, effects on copulation propensity and potential functional benefits for incubation have not previously been quantified in M. serrator. Specifically, seaweed delivery may constitute a form of a nuptial gift and indicator of male genetic or parental quality to increase copulation rates and paternity, similar to nuptial feeding e.g., in common terns Sterna hirundo (Gonzalez-Solis et al., 2001). Equally, there might be alternative or additional, direct thermoregulatory benefits of the incorporation of seaweed into the nest. Insulation benefits are well illustrated in nests of passerines (McGowan et al., 2004, on long-tailed tits Aegithalos caudatus) and females choosing high quality mates associated with high quality nests may benefit through decreased incubation effort and increased hatching success (Grubbauer & Hoi, 1996, on the penduline tit Remiz pendulinus).

Accordingly, the nesting material deployed by M. serrator may serve to maintain the regulated foot temperature of incubating Australasian gannets through thermo-insulation, helping to stabilise the temperatures required for successful embryonic development. This might be especially relevant to gannets, which, like most pelicaniform seabirds, do not develop brood patches.