DETERMINATE AND INDETERMINATE EGG-LAYING PATTERNS: A REVIEW[1]

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Abstract. Patterns of egg laying were recorded for 104 bird species by surveying the literature for experiments that involved removal or addition of conspecific eggs during laying. Although results were presented for all 104 species, data were considered sufficient to reliably determine laying type for only 46 species. Of the 46 species, 24 were determinate layers; they did not lay extra eggs in response to egg removal or did not curtail laying in response to egg addition. Twenty-two species were indeterminate layers. Three types of indeterminate laying were revealed: removal indeterminacy, in which birds responded to egg removal by laying extra eggs; addition indeterminacy, in which birds responded to egg addition by laying fewer than normal host eggs; and removal-and-addition indeterminacy, in which birds responded to egg removal by laying more eggs than normal and to egg addition by laying fewer eggs than normal. The frequency of indeterminacy increased with clutch size: none of the three species with single-egg clutches were indeterminate, 15 of the 32 species (47%) with average clutches of 2-8 eggs were indeterminate, and 7 of 11 species (64%) with average clutches of more than eight eggs were indeterminate. No differences were found in the frequency of laying types between birds with precocial and altricial young. The timing of egg removal and addition affected the experimental results; manipulations should be done early in laying in order to effectively evaluate laying pattern. Finally, I suggest a protocol for further experiments designed to examine laying type.

Key words: Indeterminate laying; determinate laying; brood parasitism; egg removal; clutch size.

INTRODUCTION

In some birds, the number of eggs laid is influenced by factors at the time of laying. Birds that respond to either removal or addition of eggs during the laying period by laying extra eggs or curtailing laying, respectively, are known are "indeterminate layers"; birds in which the number of eggs laid in a clutch is determined at the onset of laying and cannot be changed by removal or addition of eggs are known as "determinate layers" (Cole 1917, 1930; Davis 1955).

Although a variety of species have been examined with regard to their response to egg removal, and a lesser number with egg addition, there is no consensus on the incidence of indeterminacy in birds. Lack (1947:315) suggested that, except for pigeons, doves, Herring Gulls (*Larus argentatus*) and other charadriiformes, most birds are indeterminate layers. Skutch (1976:140), however, claimed that few birds were indeterminate layers; he considered Northern

Flickers (*Colaptes auratus*), Wrynecks (*Jynx torquilla*), House Sparrows (*Passer domesticus*), Gentoo Penguins (*Pygoscelis papua*), Adelie Penguins (*P. adeliae*), Black-headed Gulls (*Larus ridibundus*), and House Wrens (*Troglodytes aedon*) to be possibly indeterminate, and most other birds to be determinate layers. Klomp (1970) noted that many studies of laying patterns have been incomplete or inadequate, thus preventing general conclusions; however, he suggested that all species that lay a single egg are determinate (Klomp 1970:3).

Clutch size has long been of interest to biologists. Laying patterns are a product of the mechanisms that control follicle growth and ovulation. Although some species, such as Brant (*Branta bernicla*) and Snow Geese (*Chen caerulescens*), are apparently determinate due to a limited number of developing follicles (Barry 1960, 1962), many species produce more developing follicles than eggs (Klomp 1970). The latter species have the potential to be indeterminate layers, although not all exhibit indeterminacy. Clutch size is therefore determined by the cessation of laying rather than the inability to produce more eggs (Lack 1947:316).

Indeterminacy has been defined by the re-

sponse to removal or addition of eggs during laying, specifically to removal or addition by humans. However, until recently, indeterminacy has not been related to naturally occurring egg removal and addition (Kennedy and Power 1990). Indeterminacy may be an adaptation to maintain a clutch size that maximizes fitness in populations which display brood parasitism (con- or interspecific) or nest competition with conspecific egg predation or removal. Because egg removal and addition may occur independently, Kennedy and Power (1990) suggested that birds need not respond indeterminately to both removal and addition to be categorized as indeterminate layers (see Holcomb 1971). Rather, birds may be determinate, "removal indeterminate" only, "addition indeterminate" only, or both "removal-and-addition indeterminate" (Kennedy and Power 1990).

Kendra et al. (1988) suggested that indeterminacy may be a prerequisite for conspecific brood parasitism rather than a response to brood parasitism or egg removal. However, some determinate layers, such as European Starlings (*Sturnus vulgaris*), exhibit high rates of conspecific brood parasitism (Power et al. 1989), which suggests that indeterminacy is not a prerequisite for brood parasitism. (It is unknown whether the ancestors of birds were determinate or indeterminate; crocodilians, the group of extant reptiles most closely related to but not ancestral to birds, generally store eggs and lay in batches of 12–55 eggs at a time [Ferguson 1985]).

Here I review the literature on egg removal and addition during laying to determine the extent of the types of indeterminacy and the relationships of ecological and taxonomic factors to laying patterns. I also suggest a rigorous protocol for the study of laying patterns in birds.

MATERIALS AND METHODS

I reviewed the literature for studies in which egg removal and conspecific egg addition during the laying period were performed or reported. Whenever possible, primary sources were used. However, some sources contained anecdotal information that had been told to the author and could not be verified (e.g., Grabham 1897, Goodwin 1948). Other sources stated that eggs were removed or added and that no birds extended their laying but did not give the actual method of removal or addition (e.g., Dilger 1960, van Balen 1984). A few sources could not be obtained and

information was included based on reports elsewhere (e.g., Kreymborg [cited in Laven 1940a], Yonge [cited in Nelson 1983]; see Appendix).

The following information for each study is listed in the Appendix: species, treatment (method of removal or addition), number of nests, response to the treatment (determinate or indeterminate), mean or maximum number of eggs laid (whichever is used by the author), "normal" clutch size (or range of clutch sizes), and known incidences of conspecific brood parasitism. I defined a response as "indeterminate" if, during the laying period, individuals adjusted their clutch sizes to either egg removal (by increasing egg production) or egg addition (by decreasing egg production). A species that did not change the number of eggs laid in response to either treatment was categorized as "determinate." Individuals that, in response to removal, increased egg production following an interruption of more than one day in the laying cycle were categorized as "determinate," because interrupted bouts of laying most likely represent a series of determinate laying cycles (Davis 1955).

The normal clutch size (or range of clutch sizes) listed for each species was based on information given in the primary source or, secondarily, from values given in Harrison (1975, 1978). Information on the existence of brood parasitism in a species, including mention of two new eggs in a nest in one day, was obtained from primary sources or recent reviews (Yom-Tov 1980, MacWhirter 1989, or Rohwer and Freeman 1989).

Assessment of laying patterns provided by many studies must be considered as provisional because of: 1) small sample size (46 species are represented by a single nest or an unknown number of nests); 2) unreported method of removal or addition (e.g., eggs may not have been removed on a continuous basis, or eggs were removed over an extended period of time and may actually represent several discrete clutches rather than extended laying; see Discussion); or 3) poor timing of egg removal or addition (removal or addition in a nearly completed clutch is likely to result in a species being labeled determinate, whether it is or not). In the Appendix, unreliability of laying status is indicated by a question mark.

Most studies that involved more than one nest reported variation in responses among individual birds. I have listed all reported responses in

TABLE 1. A. Laying type of 104 species as a function of clutch size. Species are listed as determinate, removal indeterminate (if they responded to egg removal by laying extra eggs), addition indeterminate (if they responded to egg addition by laying fewer eggs), or removal-and-addition indeterminate (if they responded to both treatments as above) on the basis of their response to egg removal and/or addition. Most species were subjected only to removal experiments; N represents the number of species, and % represents the percentage of determinate species for each clutch-size range. B. Laying type of the 46 species for which data seem reliable (see text).

| | | | | Laying type | | |
| | | | | | Indeterminate type | |
Clutch size	Total N	Determinate N	Determinate %	Removal	Addition	Removal-and-addition
A.						
1	6	6	100	0	0	0
2–8	79	45	57	30	2	2
>8	19	5	26	10	2	2
B.						
1	3	3	100	0	0	0
2–8	32	17	53	11	2	2
>8	11	4	36	3	2	2

the Appendix, and have labeled species as indeterminate if at least 20% of the birds that did not desert a treatment exhibited an indeterminate response. This arbitrary value is large enough to prevent a species from being labeled as indeterminate on the basis of the laying of only one of many birds. For example, Mew Gulls (*Larus canus*) have often been labeled as indeterminate on the basis of von Torne's (1940) study in which only one of 33 gulls responded to egg removal in an indeterminate way. Here I reported the results of that study as determinate.

I excluded studies in which naturally occurring interspecific or conspecific brood parasitism may have affected clutch size (e.g., see Weller 1959, Middleton 1977, Møller 1987, and Brown and Brown 1989). Natural experiments such as these do not control for the possibilities that parasites can assess which host females are likely to lay small clutches (Brown 1984) or that "high-quality" host females may avoid parasitism (Rohwer 1984). Therefore, for examining addition indeterminacy I have limited this review to studies in which conspecific eggs were added experimentally.

I have likewise excluded studies in which all egg removal occurred after clutch completion

(e.g., Fredrickson 1969); such studies examine a bird's ability to lay a replacement clutch rather than indeterminacy.

RESULTS

Information on laying patterns was found for 104 species, representing 34 families and 17 orders (Appendix). Overall, 56 species (54%) were determinate (Table 1A). All six species with single-egg clutches were determinate layers. More than half of the species that normally laid clutches of 2–8 eggs were determinate (45 of 79, 57%), while only one-quarter of those that laid clutches of more than eight eggs (mostly ducks and galliformes) were determinate (five of 19, 26%). Eight species were categorized as addition indeterminate or removal-and-addition indeterminate. However, only 38 species were subjected to egg addition; thus, 21% of species to which eggs were added exhibited addition indeterminacy. Of the 46 species with reliable data, 24 were determinate (52%), including four of 11 species with clutches of more than eight eggs (36%) (Table 1B). Eight of the 26 species (31%) with reliable information on egg addition exhibited addition indeterminacy.

Conspecific brood parasitism has been documented in 22 of the 46 species with reliable data but experimental egg addition occurred in only 14 of these 22 species. Only five of the 14 species (36%) were addition indeterminate. Among the 26 species in which egg addition occurred (see above), addition indeterminacy was not more common in species with brood parasitism than in those in which parasitism has not been found or reported (five of 14 vs. three of 12; $G = 0.351$, df = 1, $P > 0.50$).

RELATIONSHIP OF TAXONOMY TO INDETERMINACY

No overall relationship between indeterminacy and taxonomic group was found. In some families, all species listed were either determinate (Muscicapidae), removal indeterminate (e.g., Podicipedidae, Accipitridae, Falconidae, Phasianidae, Charadriidae, Picidae), or removal-and-addition indeterminate (Paridae); however, relatively few members of each family were represented. Most families were represented by either a mixture of laying patterns (e.g., Anatidae, Rallidae, Laridae, Emberizidae) or by only a single species.

PRECOCIAL VERSUS ALTRICIAL SPECIES

The factors that determine clutch size may differ between precocial (as defined by Winkler and Walters [1983]) and altricial species (Lack 1947). However, the frequency of indeterminacy did not differ between precocial and altricial species, either for all species (25 of 44 precocial vs. 23 of 60 altricial, $G = 3.502$, df $= 1$, $P > 0.05$) or for the 46 species with reliable data (14 of 23 precocial vs. 8 of 23 altricial, $G = 3.173$, df $= 1$, $P > 0.05$) (Table 2).

Precocial species. Overall, 19 of the 44 precocial species (43%) were determinate layers (Table 2A). Of the 23 precocial species with reliable data, nine were determinate (39%, Table 2B). Only the 23 species with reliable data were included in the analysis below.

Egg removal occurred at nests of 21 of the 23 species. The response of these species depended on the time of removal: if the first egg was removed shortly after it was laid, 8 of 11 species responded in an indeterminate way by laying at least one extra egg. However, if the first egg remained in the nest and subsequent eggs were removed, only six of 15 species responded indeterminately. Six species, Gentoo Penguins, Mallards (*Anas platyrhynchos*), Northern Lapwings (*Vanellus vanellus*), Common Black-headed Gulls, Herring Gulls, and Lesser Black-backed Gulls (*Larus fuscus*), were subjected to both removal treatments: five of the six responded indeterminately if removal began with the first egg but determinately if removal began with the second (or later) egg. Only Mallards also responded indeterminately if removal began with the second or third egg. (Lesser Black-backed Gulls gave different responses in the same study.) Unlike the other five species, Mallards have large variable clutches.

Reliable information for egg addition was available for only seven precocial species. If eggs were added to empty nests of Herring Gulls or Common Black-headed Gulls before host laying, many birds responded indeterminately by laying a smaller-than-normal clutch. In Herring Gulls, this result was obtained in three geographically distinct studies (Appendix). However, if eggs were added to nests following the laying of the first egg, Herring Gulls responded determinately (i.e., laid three host eggs) (Appendix).

The other species in which experimental addition during laying occurred were Pied-billed

TABLE 2. A. Laying type of 104 species as a function of development. Species are separated into two categories, precocial and altricial, on the basis of the development of their young (see Winkler and Walters 1983), and are listed as determinate, removal indeterminate, addition indeterminate, or removal-and-addition indeterminate (see Table 1 for conventions). B. Laying type of the 46 species for which data seem reliable.

Development of young	N	Determinate	Laying type		
			Indeterminate type		
			Removal	Addition	Removal-and-addition
A.					
Precocial	44	19	21	2	2
Altricial	60	37	20	2	2
B.					
Precocial	23	9	10	2	2
Altricial	23	15	4	2	2

Grebes (*Podilymbus podiceps*), Wood Ducks (*Aix sponsa*), Common Goldeneyes (*Bucephala clangula*), Blue-winged Teal (*Anas discors*), and Northern Lapwings. The ducks and grebes, in contrast to the gulls and lapwings, have relatively large, variable clutch sizes. In Wood Ducks and Common Goldeneyes, but not in Blue-winged Teal, early egg addition (addition of one or several eggs to nests with only 1–4 host eggs) resulted in a reduced host clutch size (Appendix). In Goldeneyes, the reduction in host clutch was equal to the number of eggs added (either one or four), indicating a one-to-one response to added eggs. However, if eggs were added to Goldeneye nests that contained five or more host eggs, host clutch size was not affected, and laying was determinate (Appendix).

Altricial species. Overall, 37 of the 60 altricial species (62%) were determinate (Table 2A). Of the 23 altricial species with reliable data, 15 were determinate (65%, Table 2B). Only these 23 species were included in the analysis below.

Removal of the first eggs (and usually subsequent eggs) resulted in indeterminate laying in five of 13 species. When the first egg remained in the nest and some or all subsequent eggs were removed, most species (14 of 19) responded in a determinate manner.

Addition experiments generally resulted in determinate laying. Eggs added to an empty nest prior to laying were reported for only nine spe-

cies. Rock Doves (*Columba livia*) were categorized as indeterminate because five of 10 birds in this experiment responded by laying no eggs of their own and incubating the artificial eggs (the other five birds in this experiment laid the normal clutch of two eggs). Seven species, Eurasian Kestrels (*Falco tinnunculus*), Eurasian Skylarks (*Alauda arvensis*), Pied Flycatchers (*Ficedula hypoleuca*), Yellow Warblers (*Dendroica petechia*), Prairie Warblers (*D. discolor*), Red-winged Blackbirds (*Agelaius phoeniceus*), and Tricolored Blackbirds (*A. tricolor*), were determinate; and European Starlings removed the added eggs before laying determinately. Eggs were added to nests of 17 species during the early part of the laying period (days 1–3) but were responded to indeterminately by only three species: House Sparrows, Great Tits (*Parus major*) and Blue Tits (*P. caeruleus*). All species, including House Sparrows, to which eggs were added late exhibited determinate laying.

DISCUSSION

RELATIONSHIPS OF CLUTCH SIZE AND HORMONAL EFFECTS TO INDETERMINACY

Clutch size. Generally, laying pattern appeared to be related to clutch size. Birds with clutches of one egg were determinate, supporting Klomp (1970), while birds with large clutches (more than eight eggs) were mostly removal indeterminate (most of the birds with large clutches were ducks or galliformes).

Determinacy may result from either the production of a few ovarian follicles, as seems to occur in Brant and Snow Geese (Barry 1962), or the maturation of a larger number of follicles than are ovulated, as occurs in several species of African parrots (*Agapornis* spp.; Dilger 1960). Although species with a limited number of follicles could produce fewer eggs than follicles due to atrophy of follicles (atresis), such species could not be removal indeterminate. Removal indeterminacy can only occur in species in which relatively large numbers of follicles are produced.

Among indeterminate species, the termination of laying may be due to different cues; e.g., gulls probably respond to the tactile stimuli of eggs against the brood patch (Winkler and Walters 1983) but galliformes may respond to the visual stimuli of a collection of eggs (Steen and Parker 1981). Thus, species may respond to egg removal or addition in a similar way but for different reasons.

Hormonal effects. Hormonal cues may differ among species. However, in some, if not most species, the onset of incubation probably causes developing follicles to atrophy (Eisner 1960, cited in Klomp 1970) and ovulation to cease (Mead and Morton 1985). Before and during laying, follicle development is influenced by follicle-stimulating hormone (FSH), and ovulation probably occurs when levels of both luteinizing hormone (LH), released from the anterior pituitary, and progesterone, released from the mature follicle, peak (see Mead and Morton 1985). Levels of FSH and LH are inhibited by the high levels of prolactin that are released during incubation; the decline in FSH results in atresia of follicles (Lehrman 1959), and the decline in LH prevents release of additional oocytes (Mead and Morton 1985).

The initial development of extra follicles may enable a bird to replace eggs lost before the onset of incubation. Kendra et al. (1988) suggested that a critical period exists in House Sparrows; egg removal that occurred before the third egg was laid could result in further laying, but egg removal after the third egg had no effect. (However, Anderson [1989] failed to corroborate this finding.) If eggs are removed prior to incubation, this may delay incubation and its accompanying release of a threshold level of prolactin. As a result, follicle development and ovulation may continue, and additional eggs may be released. Likewise, if eggs added to a nest early (even before host laying) are accepted and incubated by a bird, early release of prolactin may curtail laying, particularly in birds that normally lay small clutches and begin incubation before laying the second egg, such as gulls and Rock Doves. Hector and Goldsmith (1985) found that prolactin levels actually rise before ovulation in *Diomedea* albatrosses, which lay one-egg clutches. A similar prelaying rise in prolactin in other species with one-egg clutches would explain why all such birds have been demonstrated to be determinate.

RELATIONSHIPS OF BROOD PARASITISM AND EGG REMOVAL TO INDETERMINACY

No relationship between addition indeterminacy and conspecific brood parasitism was detected. Conspecific brood parasitism occurred with approximately equal frequency in indeterminate and determinate layers. However, in many cases, brood parasitism has been reported in populations other than those in which egg removal or addition has been carried out. Thus, for these factors to be examined properly, laying experi-

ments should be carried out in the same populations in which brood parasitism occurs.

Addition indeterminacy may represent one of several ways for a species to deal with extra eggs laid by brood parasites; removal of parasitic eggs, nest desertion, and "leaving space" for parasitic eggs represent alternative responses to natural egg addition (Power et al. 1989). Eggs added to complete but empty nests before host laying were removed from the nest by European Starlings (Stouffer et al. 1987) and Barn Swallows (Møller 1987) but not by Pied Flycatchers (von Haartman 1967), Yellow Warblers (Sealy et al. 1989), Prairie Warblers (Nolan 1978), and Tricolored Blackbirds (Emlen 1941).

Many studies reported that some birds deserted experimental nests. In some studies, birds were individually marked and known to renest in either the same or other nests. Desertion is a more common response than indicated in the Appendix; in many studies, only successful nests were reported.

Most cases of indeterminacy in the species reported here are based only on a bird's response to egg removal. However, naturally occurring egg removal has not been reported for many species, and thus the relationship of indeterminacy to natural removal was not examined.

Some species are subject to both brood parasitism and egg removal (e.g., European Starlings [Lombardo et al. 1989]). Such species may be able to adjust their clutch sizes in response to both conditions. Both removal and addition experiments were conducted on only 23 species: 12 species were determinate layers, four species were removal-and-addition indeterminate, five species were removal indeterminate, and two species were addition indeterminate. These results support the suggestion that response to removal and addition may be independent.

RELATIONSHIP OF TIMING OF REMOVAL OR ADDITION TO INDETERMINACY

The likelihood of detecting indeterminacy was related to the timing of egg removal or addition, especially in precocial birds. In several species, removal of the first egg or addition before laying the first egg generally resulted in indeterminate laying, but later manipulations resulted in determinate laying. Budgerigars (*Melopsittacus undulatus*), altricial birds which lay an egg every two days and begin incubation with the first egg, were indeterminate if the first egg was removed shortly after it was laid but determinate if the

first egg remained in the nest (Brockway 1968; unlike many altricial species, clutches of Budgerigars hatch almost completely asynchronously [Stamps et al. 1985]). In a few species, differences in the time of removal of the first egg produced different results. In Gentoo Penguins, which have a normal clutch of two, early removal of the first egg (prior to the onset of incubation) generally resulted in the laying of two more eggs, but late removal of the first egg (i.e., more than 24 hours after it was laid but before the laying of the second egg) resulted in nest desertion (Gwynn 1953).

Addition of eggs to a nest before host laying resulted in a reduction in eggs laid or, in some cases, no host laying by the incubating female in Common Black-headed Gulls, Herring Gulls, and Rock Doves. The results for the doves were surprising because, based on egg removal experiments and on the limitations of crop milk as a food source for their young, doves and pigeons are generally regarded as determinate layers.

Early addition (before half the clutch was laid) resulted in reduced clutch sizes in Great Tits and Blue Tits (Winkel 1970), House Sparrows (Kendra et al. 1988), Common Goldeneyes (Andersson and Eriksson 1982), and Wood Ducks (Heusmann et al. 1980). Dump nesting may suppress the number of host eggs laid in several other species of ducks (see Klomp 1970). Conspecific brood parasites of at least one species (European Starlings) are most likely to lay eggs in host nests during the early part of the laying period (Romagnano et al. 1990); it seems likely that parasites of other species may have similar timing. Some species might thus respond to parasitic eggs by adjusting their host clutch size so as to prevent rearing an overcrowded brood that may be less productive than a normal-sized brood.

PROTOCOL SUGGESTIONS

The major difficulty in comparing laying patterns among species is the lack of standard methods of egg removal and addition. Many studies report results from a single nest or only from those nests in which a particular response was found (e.g., Puhlmann 1914). In some studies, eggs may not have been marked as laid. In other studies, laying patterns included gaps of several days (e.g., Kendeigh et al. 1956, Kendra et al. 1988), which may represent ovulation of replacement clutches rather than indeterminate laying. And in still other studies, the timing of removal or addition may be too late to effectively show indeterminacy; we cannot know, for example, whether the deter-

minate response of the Common Chaffinch (*Fringilla coelebs*) to Chappell's (1948) addition of eggs on days 4 and 5 was because this bird was in fact a determinate layer or because the eggs were added late in the laying period.

To allow reliable conclusions about laying patterns, I propose that experimental investigations of laying pattern include the following treatments. Control: eggs may be moved around among nests. Egg removal: i) remove at least two eggs as laid beginning with the first egg, ii) remove at least two eggs as laid beginning with the second egg, and iii) remove at least two eggs as laid beginning with the middle egg (as determined by modal clutch size). Egg addition: i) add one (or more eggs) to a complete but empty nest, ii) add at least one (or more) egg to a nest for at least two days, beginning on the day of the first host egg, and iii) add at least one (or more) egg for at least two days, beginning on the day of the middle egg.

I suggest that at least two eggs be removed or added so as to increase the likelihood of detecting an indeterminate response, particularly in species that lay clutches of variable size. To detect any egg removal or brood parasitism, eggs must be marked as laid in both treatment and control nests. Eggs should be manipulated soon after laying to prevent (in the case of removal) or allow (in the case of addition) the start of incubation. In species that lay every other day, such as gulls and budgerigars, incubation begins within 24 hours after the laying of the first egg, and late removal of the first egg (more than 24 hours after laying) can yield different results than early removal.

The treatments suggested above examine laying responses to both early and late removal and addition. Where sample sizes are limited, removal and addition treatments i) and ii) should be used. If relatively large numbers of nests are available, removal and addition of different numbers of eggs according to the above patterns may reveal different responses. These treatments should be carried out in conjunction with an awareness of the possibility of conspecific brood parasitism and egg removal.

ACKNOWLEDGMENTS

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APPENDIX. Egg removal and addition experiments in 104 species, listed in taxonomic order (American Ornithologists' Union 1982). *Brood parasitism:* Y = yes (or two new eggs in one day); N = no; ? = unknown. Y^s = reported by the same author; Y^y = reported in Yom-Tov (1980); Y^m = reported in MacWhirter (1989); Y^r or N^r = reported in Rohwer and Freeman (1989); and Y (any other superscript) = reported by another author (listed at the end of this table). *Normal clutch* is the clutch size or range of clutch sizes reported for that species, preferentially given by the author for the study population, otherwise given by Harrison (1975, 1978). *Treatment:* R = removal; A = addition. Method(s) of removal or addition (if known) are indicated by subscripts as follows: R_1, R_2, R_3 = removal of, respectively, egg one only, egg two only, or egg three only; R_{1-a} = removal of all eggs beginning with egg one, leaving no egg in the nest; R_{2-a} = removal of all eggs beginning with egg two, leaving one egg in the nest; R_{2+3} = removal of eggs two and three, R_c = removal of a full clutch (all eggs removed at single time after clutch completion); R_g = removal of a group of eggs (several eggs removed at one or more times prior to clutch completion); A_0 = addition of an egg prior to host laying (i.e., addition of an egg to an empty nest); A_1, A_2 = addition of an egg on day one or two, respectively; A_{1-a} = addition of a group of eggs (more than one egg added) on day one. *Response:* I = indeterminate; D = determinate. An asterisk (*) indicates my judgement of laying type (I or D) for each species in response to removal or addition. A question mark (?) indicates the response used for Tables 1 and 2 but that the response(s) listed may not be accurate, either due to small sample size, uncertainty as to the method of removal or addition, gaps in laying, or removal or addition late in the laying cycle (see text). Numbers in parentheses represent maximum or mean number of eggs laid if known. *Number of nests:* number of nests at which a given treatment was performed; a fraction (e.g., 12/19) indicates the number of nests at which the response listed (I or D) occurred per number of nests at which that treatment was carried out. *Comments:* e = egg(s), d = day(s), rem = removed, n = nest(s), exp = experiment; e.g., 3n@2e = 3 nests each had 2 eggs laid in them.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Pygoscelis adeliae Adelie Penguin	?	2	R_1	I* (3)	12/19	4n deserted, 3n@2e	1
Pygoscelis papua Gentoo Penguin	?	2	R_{1-a}	I* (3)	4/8	4n deserted	2
			R_1	I	2/8	5n@2e	2
			R_2	D (3)	10/10	e1 incubated at all 10n	2
			R_c	D	7/7	e rem after clutch completed, no renesting	2
Eudyptes chrysocome Rockhopper Penguin	?	2	R_{2-a}	D?	6/6	no renesting if both e rem	2
Eudyptes chrysolophus Macaroni Penguin	?	2	R_{1-a}	D?	—	no experiment (observations only), no renesting if both e rem	2
Gavia immer Common Loon	Y[b]	2	R	D?	?		3
Podilymbus podiceps Pied-billed Grebe	?	5–7	R_{3-6}	I* ($\bar{x}$ = 8.14)	7	rem e 3–6 or 4–7; control $\bar{x}$ = 7.33, N = 21	4
			R_{2-a}	I (13)	1	13e laid in 15-d period	5
			R_{3-a}	D (7)	1		5
			A_{3-a}	D* ($\bar{x}$ = 7.50)	2	added 2e on @d 3 & 4;	4
Podiceps auritus Horned Grebe	?	5–7	R_{3-6}	I* ($\bar{x}$ = 8.6)	5	rem e 3–6 or 4–7; control $\bar{x}$ = 6.45, N = 11	4
			A_{3-8}	D? (6)	1	added 2e on d 3 & 4;	4
Podiceps nigricollis Eared Grebe	?	3–4	R_2	I* (6)	3/15	5n@3e, 7n@3e, 2n@5e, 1n@6e} control	6
			R_3	I (7)	2/14	5n@3e, 7n@4e, 1n@5e, 1n@7e} $\bar{x}$ = 3,4, N = 106	6
			R_4	I (5)	1/3	2n@4e, 1n@5e	6
Diomedea nigripes Black-footed Albatross	Y[c]	1	R_1	D?	?		7
Diomedea immutabilis Laysan Albatross	Y[c]	1	R_1	D*	95	e destroyed early in incubation period	7
			R_1	D	70	e destroyed late in incubation period	7

APPENDIX. Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Oceanites oceanicus Wilson's Storm-Petrel	?	1	R_1	D?	?	no renesting if e rem	8
Sula bassanus Northern Gannet	?	1	R_1	D*	2	no experiment, e lost on day 1	9
Phalacrocorax neglectus Bank Cormorant	?	1–3	R	D?	?		10
Chen caerulescens Snow Goose	Y^r	2–9	R_{1-a}	D*	37	compared ovarian follicles with clutch	11
Branta bernicla Brant	Y^y	4–6	R	D	?	lay smaller clutch if delay in initiation	12
Tadorna tadorna Shelduck	Y^y	8–15	R_{1-a}	D*	14	compared ovarian follicles with clutch	11
Aix sponsa Wood Duck	Y^r	8–10	R_{1-a}	I? (18)	?	dump nesting occurs	13
			A_g	I*	15	dump nesting common	14
Anas crecca Green-winged Teal	?	5–16	R_{4-a}	D? (9)	1		15
Anas platyrhynchos Mallard	Y^y	10–12	R_{1-a}	I (100)	?	captive birds	16
			R_{3-a}	I* (15)	9	captive, wild-stock birds: rem $\bar{x} = 11.9$, range 7–15e; control $\bar{x} = 7.6$, range 6–10e, $N = 9$	15
			R_{3-9}	D (11)	10	wild birds: rem $\bar{x} = 8.7$, range 7–11; control $\bar{x} = 9.0$ (range 7–11, $N = 28$)	15
Anas discors Blue-winged Teal	?	6–15	R_{3-a}	D* (13)	11	rem $\bar{x} = 10.7$, range 9–13e; control $\bar{x} = 10.4$, range 8–13, $N = 46$	15
Anas clypeata Northern Shoveler	Y^r	5–14	A_{2-8}	D* (11)	12	added $\bar{x} = 10.2$, range 9–11e; control above	15
			R_{3-a}	D* (8)	2		15
Anas strepera Gadwall	Y^y	5–13	R_{3-a}	D* (11)	4	rem $\bar{x} = 10.0$, range 9–11e	15
Aythya valisineria Canvasback	Y^y	7–12	R_{3-a}	D* (9)	2	n not parasitized by *A. americana* (may reduce clutch in response to Redhead e)	12
Bucephala clangula Common Goldeneye	Y^y	6–11	A_g	I* (8)	12	4e added early (d 1–4), $\bar{x} = 8$	17
			A_g	D (11)	7	4e added late (after d 5), $\bar{x} = 11$	17
Circus cyaneus Northern Harrier	?	4–6	R	I? (16)	1?		18
Accipiter striatus Sharp-shinned Hawk	?	4–5	R	I? (17)	1?		18
Accipiter cooperii Cooper's Hawk	?	4–6	R	I? (13)	1?		18
Buteo lineatus Red-shouldered Hawk	?	2–3	R	I? (9)	1?		18

APPENDIX. Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Falco tinnunculus Eurasian Kestrel	?	4–6	R_{2-4}	I*	(12)	4/6	1n@6e, 9e, 10e, 11e, 12e; 1n deserted	19
			R_{3-4}	I	(10)	2/7	2n@5e, 3n@6e, 1n@8e, 10e	19
			R_{4-4}	I	(11)	1/4	1n@5e, 2n@6e, 1n@11e	19
			A_{0-8}	D*	(5)	5/7	2n deserted, 1n@3e, 1n@4e, 3n@5e	19
			A_{2-8}	D	(6)	6/6	1n@3e, 4e, 2n@5e, 6e	19
Falco sparverius American Kestrel	?	4–6	R	I	(20)	1	unmated bird, laid 20e in succession	20
			R_{1-4}	I*	(26)	3/4	1n@26e, 18e, 13e, 3e	21
			R_{2-4}	I	(23)	4/4	2n@23e, 1n@22e, 8e } control $\bar{x}$ = 5e ($N = 3$)	21
			A_{1-8}	D*	(4)	2/2	added 4e	21
			A_{0-1}	D	(5)	1/1	added 1e prior to laying and 4e on day 2	21
Phasianus colchicus Ring-necked Pheasant	Y^y	7–15	R	I?	(76)	?	captive birds, laid 76 in season, not known if e were laid continuously	22
Chrysolophus pictus Golden Pheasant	?	5–12	R_{2-c}	I?	(>40)	?	no experiment, anecdotal report	23
Lagopus lagopus Willow Ptarmigan	Y^m	8–9	R_{1-a}	I*	(27)	11	captive birds, $\bar{x}$ = 16.8e	24
Colinus virginianus Northern Bobwhite	Y^y	12–16	R	I?	(32)	1?		18
Callipepla squamata Scaled Quail	?	12–14	R_g	I?	(19, 17)	2	rem several e every few days	25
Porzana carolina Sora	?	8–12	R	I?	(20)	1?		18
Gallinula chloropus Common Moorhen	Y^m	5–11	R_c	I?		1	rem e in sets of 9, 9 and 18 (clutches?)	26
Fulica atra Eurasian Coot	Y^r	6–9	R	D?		1		27
Fulica americana American Coot	Y^r	4–11	R_{2-a}	I*	(18)	8/10	2n deserted, rem $\bar{x}$ = 15.9, range 14–18; control $\bar{x}$ = 8.6	28
			R_{2-a}	D		?	laid 2nd and later eggs in new n	29
Vanellus vanellus Northern Lapwing	Y^r	4	R_1	I*	(5)	4/4		30
			R_{2-a}	D	(4)	5/5	bird always deserted n, laid complete clutch in nearby n (6 continuous e?)	30
			R_1	I	(5)	4/7	laid 2nd and later eggs in new n	31
			R_{1+2}	I	(6)	9/11	only 1 more laid, then always deserted	31
			R_{3-8}	D	(4)	4/4	added 1–3e	31
			A_1	D*	(4)	8/8	added 1–3e	31
			A_2	D	(4)	4/4	added 1–3e	31

APPENDIX.   Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Charadrius hiaticula Common Ringed Plover	?	4	R_1	I? (5)	?	bird deserted n, laid complete clutch in new nest (5 continuous e?)	32
			R_2	D (4)	?		32
			R_{2+3}	D (4)	?		32
			A_{2-g}	D? (4)	?		32
Haemotopus ostralegus Oystercatcher	?	2–4	R_1	D? (4)	?	added 2e to 2 in nest deserted, completed clutch in new n	33
Tringa totanus Spotted Redshank	?	4	R_c	I? (18)	1	rem e in sets: 4@4e, 1@2e (clutches?)	34
Larus ridibundus Common Black-headed Gull	Y[c]	3	R_1	I* (4)	8/23	12n deserted, 2n@3e, 1n@2e	35
			R_{1+2}	I (5)	5/12	5n deserted, 2n "doubtful"	35
			R_{1-3}	I (6)	3/6	2n deserted, 1n @5e, 1n@4e	35
			R_{1-5}	I (7)	1		35
			R_2	D (3)	10/10		35
			R_{2+3}	D (3)	2/2		35
			R_{g-2}	I (4)	5/11	4n deserted, 2n@3e	35
			A_0	I* (2–3)	17/60	26n deserted w/out incubating, 13n @0e (incubated added e), 4n@1e, 13n@2e, 4n@3e	35
Larus canus Mew Gull	?	3	R_{1-a}	D* (1–3)	32/33	1n@5e, 23n deserted after e1 rem, 7n deserted after e2 rem, 2n deserted after e3 rem	36
Larus argentatus Herring Gull	N[r]	3	R_{1-a}	I* (12)	5/15	3n@1e, 7n@2e, 2n@4e, 1n@7, 10 and 12e	37
			R_1	I* (4)	3/13	6n@3e, 3n@2e, 1n@1e	38
			R_2	D (3)	25/25	$\bar{x}$ = 2.7, range 2–3	38
			R_{3-g}	D (3)		rem after all 3 e laid	38
			R_{1-3}	I (≥4)	4/4		39
			R_{2+3}	D (3)	5/5		39
			R_3	D (3)	7/7		39
			R_{1-a}	I (≥4)	57/102	up to 12e but gaps in laying, 57n with ≥4e in succession	40
			R_1	I (4)	47/79		40
			R_2	I (5)	21/110	89n@3e, 20n@4e, 1n@5e	40
			R_{2+3}	D (3)	?		40
			A_{0-g}	I* (1–3)	21/29	$\bar{x}$ = 1.9, 7n@3e, 12n@2e, 9n@1e, 1n deserted	38
			A_{1-g}	D (1–3)	21/30	$\bar{x}$ = 2.6, 21n@3e, 6n@2e, 3n@1e	38
			A_{2-g}	D (2–3)	19/19	$\bar{x}$ = 2.8, 15n@3e, 4n@2e	38
			A_0	I (2–3)	12/15	$\bar{x}$ = 2.2, 3n@3e, 12n@2e	39

APPENDIX. Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Larus fuscus Lesser Black-backed Gull	?	3	A_1	D	(3)	3	3n deserted	39
			A_0	I	($x = 1.8$)	22	48n@3e, 6n@2e	40
			A_1	D	(3)	54		40
			A_{1-c}	D	(3)	87		40
			R_1	I*	(4)	5/5	rem e early (within 12 hours)	39
			R_1	D	(3)	5/5	rem e late (after 24 hours)	39
			R_{2-a}	I	(4)	3/3	added extra e on day 2	39
			R_{1+2}	I	(4)	3/3		39
			R_e	D	(3)	5/5	4 birds laid new nest	39
Larus glaucescens Glaucous-winged Gull	N^r	3	R_{2+3}	D	(3)	4/4	rem 1e on day 2, 2e on day 3	39
			R	I	(4)	1	rem 2e on day 2, then returned e	39
			R_1	I?	(4)	?	e1 rem shortly after laid	41
Creagrus furcatus Swallow-tailed Gull	?	1	R	D?	(1)	?	18 d gap between rem e and new e	42
Sterna hirundo Common Tern	Y	2–3	R	I?	(11)	1?		18
Uria aalge Common Murre	?	1	R	D*	(1)	20	15–17 d gap between rem e and new e	43
Columba livia Rock Dove	Y?	2	R_1	D*	(2)	10/10		44
			R_{1+2}	D	(2)	5/5	all relaid 8–10 d later	44
			A_0	I*	(2)	5/10	5n@0e brooded artificial e, 5n@2e	44
			A_1	D	(2)	5/5		44
Zenaida macroura Mourning Dove	Y^r	2	R_2	D*	(2)	30/30	1n@1e, 3n destroyed or abandoned	45
			A_1	D*	(2)	19/23		45
Melopsittacus undulatus Budgerigar	?	4–7	R_{1-a}	I*	(20)	8/8	captive birds, study halted after 20e from each female	46
			R_{2-a}	D	(7?)	8/8	captive birds	46
			R	D?		?		47
Agapornis cana Gray-headed Lovebird	?	3–8	R	D?		?		47
Agapornis taranta Black-winged Lovebird	?	3–8	R	D?		?		47
Agapornis pullaria Red-faced Lovebird	?	3–8	R	D?		?		47
Agapornis roseicollis Peach-faced Lovebird	?	3–8	R	D?		?		47
Agapornis personata Masked Lovebird	?	3–8						

APPENDIX. Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Agapornis fischeri Fischer's Lovebird	?	3–8	R	D?	?		47
Agapornis lilianae Nyasa Lovebird	?	3–8	R	D?	?		47
Agapornis nigrigenis Black-cheeked Lovebird	?	3–8	R	D?	?		47
Strix varia Barred Owl	?	2–3	R	I? (9)	1?		18
Collocalia spodiopygius White-rumped Swiftlet	Y_s	2	R_1	D? (2)	?		48
			A_1	D? (2)	?		48
Alcedo atthis Kingfisher	?	6–7	R_c	I? (20)	1?		49
Jynx torquilla Wryneck	?	7–10	R	I? (62)	1	rem in sets—7, 6, 4, 3 (clutches?)	50
			R_g	I (43)	1	rem 7, 2 gone, 1 broken, then rem as laid	50
			R	I (48)	1	rem 4–5 e every few days, some gaps in laying	50
			R_{1-a}	I (33)	1		51
Picus viridis Green Woodpecker	?	5–7	R_g	I?	1	checked n daily	52
			R_{2-a}	I? (17)	1	left 3e in n, rem 2 every 2 d	53
Colaptes auratus Northern Flicker	Y_d	5–9	R_a	I? (71)	8	71e in 73 d	54
			R_g	I (17–40)	9	results of 8 different studies?	55
			R	I (15–48)	2	rem in sets (clutches?), 9 studies?	55
			A_{4-g}	I? (21)	2/2		18
Alauda arvensis Eurasian Skylark	?	3–5	R_{3-a}	D? (4)	1	added 2e to incomplete clutch	56
			R	I (10)	3/6	3 birds deserted?	57
			A_{0-g}	D*	2/2	added 2e prior to laying	57
Hirundo rustica Barn Swallow	Y_m	4–6	R_{2-a}	D* (6)	15/15	$\bar{x}$ = 4.7, range 2–6e	58
			A_{1-g}	D* (5)	10/10	added 4–5e, $\bar{x}$ = 4.6, range 4–5e	58
Pica pica Black-billed Magpie	Y_m	5–8	R	I (21)	1	female died on nest	59
	N_r		R_{1-a}	D* (8)	15/15	$\bar{x}$ = 7.0, range 5–8e	58
			R_{2-a}	D (9)	14/14	$\bar{x}$ = 6.9, range 4–9e	58
			A_g	D* (8)	10/10	$\bar{x}$ = 5.9, range 4–8e	58
Corvus monedula Jackdaw	?	5–7	R_{1-a}	I? (18, 13)	2/?	"many deserted" after 1 or 2 e rem, others laid normal clutch	60
Corvus cornix Hooded Crow	?		$R_{2\text{ or }3}$	D* ($\bar{x}$ = 3.9)	17	control $\bar{x}$ = 4.2, N = 47	61
			$A_{1\text{ or }2}$	D* ($\bar{x}$ = 4.6)	17	control $\bar{x}$ = 4.4, N = 18	61

APPENDIX. Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Corvus brachyrhynchos American Crow	?	4–5	R_{2-a}	D*	(6)	14/15	$\bar{x} = 4.5$, range 3–6e, 1n@6e; control $\bar{x} = 4.5$	62
			R_{3-a}	D	(5)	4/4	$\bar{x} = 4.3$, range 3–6e	62
			R_g	D	(6)	11/12	$\bar{x} = 4.7$, range 3–6e, 1n@6e (irregular rem)	62
			A_{1-g}	D*	(4)	2/2	$\bar{x} = 4$, added 3 or 4e on d 1	62
			A_{1+2}	D	(5)	2/2	$\bar{x} = 4.5$, range 4–5e	62
Parus major Great Tit	N[r]	6–12	R_{1-a}	I*	($\bar{x} = 11.1$)	7		63
			R_{2-a}	I	($\bar{x} = 10.7$)	6		63
			R_{3-a}	I	($\bar{x} = 12.0$)	2		63
			A_{1-g}	I*	($\bar{x} = 8.0$)	6	control $\bar{x} = 9.5$, $N = 15$	63
			A_{2-g}	I	($\bar{x} = 7.8$)	5		63
			A_{3-g}	I	($\bar{x} = 9.0$)	4	added 6e	63
Parus caeruleus Blue Tit	N[r]	8–16	R_{1-a}	I*	($\bar{x} = 13.5$)	4		63
			R_{2-a}	I	($\bar{x} = 15.3$)	4		63
			R_{3-a}	I*	($\bar{x} = 13.7$)	3		63
			A_{1-g}	I*	($\bar{x} = 10.3$)	3	control $\bar{x} = 11.2$, $N = 10$	63
			A_{2-g}	I	($\bar{x} = 9.3$)	3		63
			A_{3-g}	I	($\bar{x} = 9.5$)	2	added 6e	63
Troglodytes aedon House Wren	Y[m] N[r]	5–8	R_{2-a}	I	(13)	1	laid sets of 13, 7, 5, and 5e with 4–5 d gaps between sets (clutches?)	64
			R_{2-a}	I	(9)	6/12	gaps in laying, maximum = 32e in 44d	65
			R_{1-a}	I*	(16)	3/22	$\bar{x} = 7.7e$, early clutches	66
			R_{1-a}	D	(7)	20/22	$\bar{x} = 5.9e$, late clutches	66
			R_{1-a}	I	(20)	4/6	$\bar{x} = 10.7e$, early clutches	67
			R_{2-a}	I	(19)	2/6	$\bar{x} = 8.8e$, early clutches	67
			R_{2+3}	I	(9)	10/25	$\bar{x} = 7.1$, early clutches, control $\bar{x} = 6.3e$	67
			R_{2+3}	D	(6)	13/13	$\bar{x} = 4.9e$, late clutches, control $\bar{x} = 4.8e$	67
			A_{1-g}	D	(7)	1	added 6e on day 1	68
			A_{2+3}	D*	(7)	23/23	$\bar{x} = 6.3e$, early clutches, control $\bar{x} = 6.3e$	67
			A_{2+3}	D	(6)	9/9	$\bar{x} = 5.4e$, late clutches, control $\bar{x} = 4.8e$	67
Troglodytes troglodytes Winter Wren	?	5–8	R_{2-a}	D*	(6)	2		69
			R	I	("many")	?		70
Cistothorus palustris Marsh Wren	N[r]	4–5	A_{3-g}	D?	(7)	2		56
			R	I	(20)	1	both laid "normal-sized" clutch and then abandoned n	18
			R_{2-a}	D?		2		71

APPENDIX.   Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Cinclus cinclus Dipper	?	4–6	R	I?	(28)	1	anecdotal, method of rem unknown	72
Ficedula hypoleuca Pied Flycatcher	Y^m	5–8	R_8	D*	(8)	17/26	9n deserted, 2 relaid in same n, 7 laid new clutch elsewhere, $\bar{x} = 6.3$e	73
			R_1	D	(8)	5	rem from 1 to 5e as laid, $\bar{x} = 7.0$	74
			A_{0-8}	D	(8)	1		74
			A_{1-8}	D*	(8)	3	rem $\bar{x} = 6.3$, control $\bar{x} = 6.3$	74
Muscicapa striata Spotted Flycatcher	?	4–5	R	D?		?	laid normal clutch	73
Phoenicurus ochuros Black Redstart	?	6–7	R	D?		?	laid normal clutch	73
Luscinia megarhynchos Nightingale	?	4–5	?	D?		?		75
Sialia sialis Eastern Bluebird	Y^m	4–5	R_8	D?	(5)	1	rem 1e on d 2, 2e on d 4	76
Turdus merula Eurasian Blackbird	?	4–5	A_{3-8}	D?	(4–5)	2	added late (d 3 or d 4)	56
Turdus migratorius American Robin	Y^m	4	R_{2+3}	D?	(3)	1		77
	N_r		R_3	D	(4)	1/2	1 deserted	77
Turdus philomelos Song Thrush	?	4–6	A_{2-8}	D?	(5)	1	added 2e on d 2	56
Sturnus vulgaris European Starling	Y^y	4–7	R	D	(5)	1	laid 2 sets of 5e with 5 d gap	78
			R_{2-4}	D*	(6)	16/16	$\bar{x} = 4.7$e, control $\bar{x} = 4.3$e ($N = 10$)	79
			R_{1-a}	D	(5)	5/5	$\bar{x} = 4.0$e	67
			R_{2+3}	D	(6)	23/23	$\bar{x} = 5.0$, control $\bar{x} = 4.7$ ($N = 21$)	67
			A_{1-8}	D*	(6)	8/10	$\bar{x} = 3.7$e, control $\bar{x} = 4.3$e ($N = 10$)	79
			A_0	D	(5)	38/38	added e were rem from n by host birds	80
			A_{2+3}	D	(7)	25/26	$\bar{x} = 4.7$, control $\bar{x} = 4.7$ ($N = 21$)	67
	?	4–5	R	I?	(16)	1		18
Parula americana Northern Parula	Y^s	4–5	A_0	D*		21		81
Dendroica petechia Yellow Warbler	N_r		A_1	D		5		81
			A_2	D		4	$\bar{x} = 4.72$, control $\bar{x} = 4.5$ ($N = 144$)	81
			A_3	D		8		81
			A_4	D		2		81

APPENDIX. Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response	Number of nests	Comments	Author[a]
Dendroica discolor Prairie Warbler	N[r]	3–5	R_{1-3}	D* (5)	2/4	$\bar{x}=4.5e$, 1n deserted, 1n depredated	82
			R_{2-4}	D (4)	1		82
			A_{0-8}	D* (4)	5	$\bar{x}=3.4e$	82
Poecetes gramineus Vesper Sparrow	?	3–5	R	I? (12)	1?		18
Emberiza citrinella Yellowhammer	?	3–5	A_1	D? (5)	1		56
			A_4	D (5)	1		56
Agelaius phoeniceus Red-winged Blackbird	N[r]	3–5	R_{1-a}	D* (4)	5/5	$\bar{x}=3.6e$	83
			R_{2-4}	D (5)	8/8	$\bar{x}=4.1e$	83
			R_8	D (4)	6/6	$\bar{x}=3.5e$	83
			A_0	D* (5)	13/13	$\bar{x}=3.6e$ control $\bar{x}=3.7$, $N=40$	83
			A_1	D (5)	13/13	$\bar{x}=3.7e$	83
			A_2	D (4)	5/5	$\bar{x}=3.6e$	83
			A_3	D (4)	4/4	$\bar{x}=4.0e$	83
Agelaius tricolor Tricolored Blackbird	Y[r]	2–4	R_2	D* (5)	5/6	$\bar{x}=3.8e$, desertion at several rem n	84
			R_3	D (5)	7/8	$\bar{x}=4.0e$, rem 2e on day 3	84
			R_4	D (4)	1	rem 2e on day 4	84
			A_0	D* (4)	2/8	$\bar{x}=3.1e$, added 1 or 2e; 2n@2e	84
			A_1	D (4)	4/21	$\bar{x}=3.0e$, added 1, 2, or 3e; 4n@2e	84
			A_2	D (4)	14/16	$\bar{x}=3.4e$, added 1, 2 or 3e; 2n@2e	84
			A_3	D (4)	2/2	$\bar{x}=3.5e$, added 1e	84
Sturnella magna Eastern Meadowlark	N[r]	3–5	R	I? (13)	1?		18
Fringilla coelebs Common Chaffinch	N[r]	4–5	A_{4-8}	D? (5)	1	added late (d 4)	56
Carpodacus purpureus Purple Finch	?	4–5	R	I? (11)	1?		18
Carduelis carduelis European Goldfinch	?	4–6	A_{2-8}	D? (5)	1		56
Acanthis cannabina Linnet	?	4–6	A_{3-8}	D? (6)	4/4	$\bar{x}=5.0e$, e added late	56
Serinus canaria Common Canary	?	3–5	R_{1-a}	D (3)	1/10	captive birds, 9n deserted	85
			R_{2-a}	D* (4)	5/10	captive birds, $\bar{x}=2.8e$, 5n deserted, control $\bar{x}=2.7e$, $N=3$ (7n deserted)	85

(Braces in the original group the four A_0–A_3 rows of Agelaius tricolor *with the note "control $\bar{x}=3.6e$, $N=141$".)*

APPENDIX. Continued.

Species	Brood parasitism	Normal clutch	Treatment	Response		Number of nests	Comments	Author[a]
Passer domesticus	Y^y	5–6						
House Sparrow			R	I	(51)	?	not known if continuous	86
			R	I	(10)	>1	females stopped laying at many n	27
			R	I	(19)	?	50e laid, 12–19 in succession	87
			R_{4-a}	D	(5)	1	late rem	88
			R_{2-a}	D	(5)	1	laid 2 sets (5, 4e) with 4d gap	89
			R_{2-a}	D*	(5)	2	rem 2e on d 2, then 1 each d	90
			R_{2-a}	D	(5)	2	2n deserted during laying (after 1–5e)	90
			$R_{1,3-a}$	D	(6)	6/16	10n deserted during laying (after 1–5e)	90
			R_{2-a}	D	(4)	2/3	laid in sets (3–5e) with 2–4 d gaps, 1n deserted after e4 rem	91
			R_{3-a}	D	(6)	2/3	1n deserted after e3 rem, $\bar{x} = 5.0e$	91
			A_{1-g}	D	(4)	1		89
			$A_{1\ or\ 2}$	I*	($\bar{x} = 4.2$)	12	added 1e, control $\bar{x} = 5.1e$ ($N = 15$)	91
			$A_{3\ or\ 4}$	D	($\bar{x} = 4.8$)	5	added 1e	91
Passer montanus	Y^e	4–6						
Eurasian Tree Sparrow			R_{2-a}	I	(16)	?	not known if continuous	27
			R_{3-a}	D?	(6)	3/3	$\bar{x} = 5.7e$, rem late	88
			R_{4-a}	D	(5)	1	rem late	88
			A_{1-g}	D?	(6)	1	} control $\bar{x} = 5.5e$, ($N = 4$)	88
			A_{2-g}	D	(6)	1		88
			A_{3-g}	D	(6)	2/2	$\bar{x} = 5.5e$, added late	88

[a] Authors are as follows: 1. Taylor 1962; 2. Gwynn 1953; 3. Yonge 1981 (cited in Nelson 1983); 4. Arnold 1990; 5. Fugle and Rothstein 1977; 6. McAllister 1958; 7. Rice and Kenyon 1962; 8. Roberts 1940 (cited in Davis 1955); 9. Nelson 1964; 10. Cooper 1987; 11. Barry 1962; 12. Bellrose 1976; 13. Hori 1964; 14. Heusmann et al. 1980; 15. Rohwer 1984; 16. Austin 1908; 17. Andersson and Eriksson 1982; 18. Rawson (cited in Burns 1900); 19. Beukeboom et al. 1988; 20. Porter and Wiemeyer 1972; 21. Porter 1975; 22. Westerkov 1956; 23. Goodwin 1948; 24. Höst 1942; 25. Wagner 1957; 26. Miller 1910; 27. Puhlmann 1914; 28. Sooter 1941; 29. Laven 1940a; 30. Rinkel 1940; 31. Klomp 1951; 32. Laven 1940b; 33. Harris 1967; 34. Bankes 1897; 35. Weidmann 1956; 36. von Torne 1940; 37. Salomonsen 1939; 38. Davis 1942; 39. Paludan 1952; 40. Parsons 1976; 41. Vermeer 1963 (cited in Klomp 1970); 42. Harris 1970; 43. Tschanz 1959; 44. Poulsen 1953; 45. Blockstein 1989; 46. Brockway 1968; 47. Dilger 1960; 48. Tarburton 1986; 49. Jahresbericht 1884 (cited in Salomonsen 1939); 50. Alderson 1897; 51. Hanke (cited in Floericke 1909); 52. Warga 1925; 53. Altum 1868; 54. Phillips 1884, 1887; 55. Burns 1900; 56. Chappell 1948; 57. Delius 1965; 58. Davis 1955; 59. Kreymborg 1911 (cited in Laven 1940a); 60. Stieve 1919; 61. Loman 1982; 62. Emlen 1942; 63. Winkel 1970; 64. Cole 1917, 1930; 65. Kendeigh et al. 1956; 66. Baltz and Thompson 1988; 67. Kennedy and Power 1990; 68. Cole (cited in Kendeigh et al. 1956); 69. Deane (cited in Armstrong 1955); 70. Deane (cited in Armstrong 1955); 71. Verner 1965; 72. Grabham 1897; 73. Berndt 1943; 74. von Haartman 1967; 75. Hilprecht (cited in Klomp 1970); 76. Nash 1942; 77. Howell 1942; 78. Riviere 1897; 79. Davis 1958; 80. Stouffer et al. 1987; 81. Sealy et al. 1989; 82. Nolan 1978:175; 83. Holcomb 1971; 84. Emlen 1941; 85. Dunham and Clapp 1962; 86. Wenzel (cited in Floericke 1909); 87. Witschi 1935; 88. Eisenhut and Lutz 1936; 89. Brackbill 1960; 90. Anderson 1989; 91. Kendra et al. 1988.
Sources of brood parasitism information are as follows: b. Nelson 1983; c. van Rhijn and Groothuis 1985; d. Burns 1900; e. Eisenhut and Lutz 1936.