

SECTION II
BREEDING BIOLOGY AND BEHAVIOUR
POPULATION ECOLOGY OF THE NEW ZEALAND SHOVELLER
ANAS RHYNCHOTIS VARIEGATA

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Although Shovellers are a cosmopolitan species, literature on their population ecology is sparse. The New Zealand Shoveller *Anas rhynchotis variegata* like other shovellers cannot be captured for tagging purposes by conventional methods. Recently, effective techniques for capture have been developed and 800 birds banded. Most are fitted with nasal saddles with different colour-combinations distinguishing the various breeding populations and year-classes.

Sight-records and hunting returns of marked birds show they are extremely mobile, ranging throughout the country haphazardly. Although widely distributed, Shovellers tend to congregate for breeding on only a few favoured grounds. Counts of pairs and broods on one breeding ground indicate that only 27 per cent of pairs nest successfully. Alternatively, many birds pair in one place but nest elsewhere. Ancestral breeding is suggested by three marked females rearing young on their natal breeding ground. During five seasons, field counts have revealed a pre-breeding sex-ratio of 62M:38F. Juveniles fledge and are shot with parity between the sexes and yet returns for all game seasons give 55M:45F.

Rates of exploitation are discussed in relation to size of population, sex ratios and productivity.

ECOLOGY OF BREEDING COLONIES OF IBIS IN VICTORIA, AUSTRALIA

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Three species of ibis breed in Victoria. *Threskiornis molucca* and *T. spinicollis* breed regularly, usually at established colonies, and *Plegadis falcinellus* breeds rarely, being recorded only in years of high rainfall. There are sixty-four known breeding colonies in Victoria, fifty-seven of which are in vegetation in marshes, three on islands in salt lakes and four in trees on dry land. The climate and water-regime associated with each colony indicates that in Victoria ibis will breed in a wide range of conditions. A stable or slowly falling water-level, with a minimum depth of one metre in the nesting area, typifies the successful colonies in marshlands.

At Mooroopna and Violet Town (200 km and 160 km north of Melbourne) the nesting of *T. molucca* was studied. Building of nests followed the recession of flood-waters. Average clutch-size was 2.7 (1-4) and the incubation period was 23-24 days. At Mooroopna in 1971-72, 59.8 per cent of eggs hatched, and 81.0 per cent of nestlings fledged. In 1972-73, 11 per cent of eggs hatched and no nestlings survived to fledgelings. In 1973-74 success was 35.7 and 72.0 per cent respectively. At Violet Town in 1972-73 no eggs hatched and in 1973-74 success was 55.7 and 58.0 per cent respectively. In 1972-73 failures are attributed to an absence of flooding; other causes of losses included predation (fox, snake, crow), weather, drowning and adults failing to return to nests.

A LONG-TERM STUDY OF BREEDING FULMARS IN SCOTLAND

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A breeding population of colour-ringed Fulmars *Fulmarus glacialis* has been studied on Eynhallow in the Orkney Islands for twenty-five years without interruption. The data are now being prepared for analysis by computer and preliminary results are given.

An early estimate of the mean adult survival rate, 93.78 per cent per annum, is superseded by a statistical study by R. M. Cormack who calculates 94.4 per cent, giving a mean duration of adult life of 16.2 years, with no difference between sexes. However, when considering the survival to 1970 of cohorts of adults marked in 1951, 1955, 1960, 1963 and 1966, he found that the mean survival rate progressively increased, from 92.2 to 96.3 per cent, possibly indicating a poorer survival of the 'older' cohorts and providing evidence of possible senility.

The data show a statistically significant lower probability of detection of surviving marked birds in the first year after marking, compared with two years after catching, and this effect is stronger in the year after initial capture than after subsequent capture. This is so far unexplained. There is no difference between the sexes. Though birds are long-lived, tenure of site tends to be short, averaging 4-5 years. Factors tending to increase the probability of changing sites are little experience of breeding and failure to rear a chick in the previous year. There is no difference between sexes.

Over the twenty-five years subcolonies of Fulmars have waxed and waned in different parts of the island, independently of general trends in the total number of breeding birds.

MORTALITY AND LONGEVITY IN THE LAYSAN ALBATROSS *DIOMEDEA IMMUTABILIS*

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The data were gathered on Midway Atoll, North Pacific Ocean, between 1960 and 1972, from more than 40,000 recaptures of banded birds and from 8,381 marked nests.

Loss before hatching among 2,787 eggs varied annually from 27 to 45 per cent, and loss before fledging was from 24 to 51 per cent in 2,303 nests. Mortality in 4,512 fledgelings moving from their colonies to the beaches, preparatory to going to sea, was 3.2 per cent. Average annual mortality at sea was 7.5 per cent in 6,990 fledgelings to four years old. Between ages of four and eight years mortality was 1.5 annually. Fifty-five to 58 per cent survived to breeding age.

Mortality in first and second years after first breeding was 2.1 to 4.0 per cent in 1,960 birds, 3.7 to 6.8 per cent per year in years three to six, and 1.3 to 3.9 per cent per year in years seven to nine after first breeding. Annual mortality among 1,905 breeding birds of unknown ages averaged 5.3 per cent, indicating a reproductive lifespan of fifteen to twenty years, and an actual lifespan of twenty-two to twenty-eight years. In 1972 we recaptured: 5 per cent of 100 at actual age twenty-nine; 7 per cent of 200 at a minimum of thirty-eight years; and 3 per cent of 398 birds at least forty years of age.

No sexual variation in mortality or longevity was found.

ASPECTS OF THE ECOLOGY OF THE NEW ZEALAND ROBIN *PETROICA AUSTRALIS*

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Annual mortality of adult Robins on the mainland varies round 30 per cent. It is equal for males and females of pairs, but mortality of bachelor territorial males exceeds 80 per cent. More than 50 per cent of losses of adults occur during three autumn months. Territories can differ greatly in size between years and in the same year. Adults are sedentary, but 6 to 14 per cent of the young are lost from the population by emigration. Mortality of young Robins is usually heaviest during nesting because of introduced mammals and for the months after independence and before autumn. Survival of young during two winters was over 92 per cent and was under 37 per cent in the first winter. The size of the breeding population declined following the latter winter and increased following the other two winters. Mainland sub-populations can show great changes in numbers of breeding birds, which are out of phase with or in opposition to general trends. Adults that die in the spring are not replaced by other adults and this also can occur in autumn and winter.

On a mammal-free island, territories are many times smaller than on the mainland. Adult mortality was only 16.7 per cent during one year. Reproductive potential is lower than on the mainland. Over 70 per cent of the young alive in winter failed to obtain a breeding area, but remained in the population as non-breeders.

REPRODUCTIVE BIOLOGY OF THE WHITE TERN *GYGIS ALBA*

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The White Tern lays its single egg on a bare surface above the ground. On Midway I., Hawaiian Is., I studied individually marked birds from March to June 1970. Both parents participate in selecting the nest-site and share incubation. The hatchling is highly specialized for gripping the substrate but is imperfectly homoiothermal. Both sexes share in brooding and feeding, but after the first few days the chick is left alone while the parents go to sea and chicks often die from exposure. I obtained detailed data on growth rates and development of behaviour of chicks and performed experiments on the attachment of adults and chicks to sites and on individual recognition of eggs, chicks and adults. These will be discussed in relation to breeding success.

ECOLOGY OF THE BLACK PETREL *PROCELLARIA PARKINSONI*

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This species is a small derivative of the subantarctic White-chinned Petrel *Procellaria aequinoctialis*, which has established itself in the sub-tropical zone. It is known to breed now only on Little Barrier and Great Barrier Islands, having disappeared from several former colonies on the main islands. The total population is estimated to be less than 2,000.

Breeders return to Little Barrier in October–November. Males usually prepare the nest. There is an absence of 3–4 weeks before laying, which extends from 23 November through December. Incubation lasts about sixty days; there are four main spells, each of about fifteen days' duration. Chick-rearing takes about 105 days; feeds are infrequent; chicks depart in May or early June. Except for earliest breeders, pairs that rear a chick to emergence will normally fail to do so the following year.

Feral cats killed 65 per cent of fledgelings in 1972 and 90 per cent in 1973. Cats rarely attack breeding adults but chicks are very vulnerable when they begin emerging. As a result, this population is apparently declining.

Stomach contents (40+ specimens) indicate that cephalopods are the main prey; some fish are taken; Crustacea have not been detected. Only cephalopods have been identified further (by their beaks); these show that Black Petrels feed at night on mainly bioluminescent, vertically migrating, deep-sea species. The main feeding zone is probably about 600 km eastwards.

SEASONAL VARIATION IN THE MORTALITY OF THE LAPWING *VANELLUS VANELLUS*

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All European banding recoveries of Lapwings were analysed by computer. Calculations of mortality were made and some analytical methods investigated. The values for mean annual mortality (m_x) among different European populations vary considerably (30-49 per cent). According to replicated G-tests these differences are, however, not significant, not even between the continental and the partly migratory British populations.

M_x for adult birds (pooled populations) is 32.2 per cent \pm 0.53 and the mortality of first-year birds between August and March 40.6 per cent \pm 0.87. This higher first-winter mortality is accompanied by slightly higher shooting of first-year birds.

There is a regular annual fluctuation in the monthly mortality rate, adults (2-8 years) having their lowest mortality in July (1.0 per cent) and the highest in January (7.2 per cent), and first-year birds the lowest in October (2.8 per cent) and the highest in January (8.4 per cent). Expectation of further life shows a reciprocal curve ranging between twenty-nine and twenty-three months. Mortality during spring migration is about twice as high as during autumn migration. The fast spring migration may be a bigger physical effort than the more leisurely autumn migration and the birds are more likely to be affected by bad weather. There is a correlation between monthly percentage of birds shot, the mortality rate and the absolute number of recoveries. Generally, human predation in southern Europe is to be considered a main factor of mortality.

THE BREEDING BIOLOGY OF THE MAGELLANIC PLOVER *PLUVIANELLUS SOCIALIS*

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The Magellanic Plover is a rare shore-bird that is restricted to a small area of Tierra del Fuego and southern Patagonia. Although it has been traditionally classified with the Charadriidae, its relationships are unresolved. Observations in Tierra del Fuego in October-November 1973 revealed that many aspects of its breeding biology differ markedly from those of typical plovers. It nests early in the austral spring on the shores of small lagoons. Territories are strongly defended by both members of the pair, often displaying together, from arrival until after the chicks fledge. Both sexes incubate the two large eggs, but in most broods one young is lost soon after hatching. The growth rate of the surviving chick is low, but fledging success is high. Magellanic Plovers possess a well-developed crop. The young are fed by the adults until after fledging, and apparently sometimes by regurgitation. The use of the feet in digging for food by this shore-bird, too, seems unique.

Aspects of the breeding biology, including a description of the natal down of the chick, which may suggest the taxonomic affinities of this unusual species, will be discussed. The presentation will be supplemented by photographs of the species on its nesting ground.

RELATION OF RAINFALL TO REPRODUCTIVE SUCCESS IN CALIFORNIA QUAIL

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In arid foothills of the San Joaquin Valley, wet winters appear to stimulate high breeding success in California Quail *Lophortyx californicus*. Age ratios in Quail taken in one locality (Shandon) over twenty-eight years and involving 15,166 birds are used as a basis for correlating breeding success with weather data. The most important factor influencing breeding is the amount of moisture in the soil just before nesting. Favourable moisture and temperature induce a growth of annual broadleaved forbs; quail eat their green leaves, which seem to contain nutrients that stimulate sexual activity highly. Additionally, the forbs produce seeds that supply the food required by young Quail. Conversely, in dry years the foothills produce mostly annual grasses and few forbs; breeding is desultory.

The critical nutritive component of forb leaves has not been identified. It does not appear to be Vitamin A. Studies are continuing to test the hypothesis that the key component might be one or more steroid compounds.

THE MATING SYSTEM AND SEXUAL SELECTION IN TWO LEK-FORMING SPECIES OF MANAKIN

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The neotropical family Pipridae includes many species in which the males are totally liberated from a parental role, have evolved striking epigamic plumage and display communally, often at traditional mating arenas. A comparative five-year study of lek behaviour was made on sympatric colour-banded populations of Golden-headed and White-bearded Manakins in Trinidad (W.I.). Particular attention was devoted to determining the role and mechanisms of sexual selection in the evolution of the lek-phenomenon.

The distribution of matings among the promiscuous males at all leks was highly non-random. Typically females made several nesting attempts per season and the great majority exhibited an exclusive attachment to a particular mate within but not between seasons. Many polygamous hens also showed a significant preference for one of their mates. Female polygamy probably exerted a negligible effect on the degree of genetic variation in the population, because most polygamous females succeeded in rearing at most only one brood sired by one of the same mates chosen by the monogamous hens per season. Mating distributions of both species were determined primarily by female choice. Territorial characteristics (notably spacing), size of lek and male aggressiveness were among the factors influencing selection of mate by females.

The results support the concept of a prominent role for sexual selection in the evolution of manakin leks. The adaptive significance of a female choice based partially on non-morphological male characters is discussed.

DOUBLE-BROODEDNESS AND REPRODUCTIVE SUCCESS IN A POPULATION OF CASSIN'S AUKLET *PTYCHORAMPHUS ALEUTICUS*

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The reproductive cycle of Cassin's Auklet *Ptychoramphus aleuticus* was studied for forty-two weeks during 1969-71 on Southeast Farallon Island, California. The timing of laying in 1969 and 1970 was similar, but in 1971 the eggs were laid one month

earlier than in 1970. In both later years, 10-15 per cent of the population lost or deserted the first clutch and laid replacement eggs. In 1971 at least 30 per cent of the population laid a second clutch after successfully raising the first brood. This may be the first documented instance of double-broodedness among seabirds. Reproductive success was 0.71 fledgelings per burrow in 1970 and 0.66 in 1971. Auklets breeding early in the season were more successful than those breeding later. Instantaneous growth rates of nestlings of the first brood was 6.5 per cent for the first thirty-six days, and 4.9 per cent for the second brood. Fledgelings of first broods were significantly heavier and older at fledging than were those of second broods. Circumstantial evidence from data on the supply of food indicated that differences in laying yearly, breeding success and rates of growth of nestlings raised at different times of the season are strongly affected by changes in availability of food.

TIMING OF BREEDING IN THE RED-BILLED GULL

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The Red-billed Gull *Larus n. scopulinus*, an inshore plankton feeder, has an extremely long laying period. At the Kaikoura Peninsula laying extends for eight weeks. Some of this variation is because females differ in retaining and changing mates from the previous season and because the female and male differ in age. If allowances are made for these factors some individuals lay consistently early or consistently late. In the absence of other known factors this constancy probably reflects a difference in the ability of individuals to attain breeding condition.

Rates of survival after fledging show that females laying early in the season are more productive than those that lay later. To breed early, females begin laying before the supply of food has increased in abundance and the difficulty they experience in obtaining food for forming eggs is reflected in small sizes of the eggs. Furthermore the replacement clutches of early breeders are often larger than the original clutch. It appears that the advantage in laying early is greater than delaying breeding even although it would enable the female to lay larger eggs and more eggs per clutch. It also indicates that the availability of food to individuals affects clutch-size.

FIDELITY OF INDIGO BUNTINGS PASSERINA CYANEA TO SITES OCCUPIED IN PREVIOUS BREEDING SEASONS

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A total of 535 Indigo Buntings was banded on a 75-hectare study area at Bloomington, Indiana, USA, between 1958 and 1973. These consisted of 165 adult males, 126 adult females, 185 nestlings that survived to leave the nest and fifty-nine immatures, most of them independent. Of these, fifty adult males were re-caught later, as were thirty-four adult females, three nestlings representing both sexes and one immature of each sex. Many birds netted did not breed on the area and would not be expected to show attachment to it. Among adults that bred on the area, twenty-eight out of forty-three males returned in at least one later year, and nineteen out of forty females did so too. Many individuals returned repeatedly; the annual rate was unaffected by advancing age. Counting an individual as one unit for each year it supplied data, the annual rate of return of breeding males was about 60 per cent; the detected annual rate of breeding females was about 50 per cent. Distances between the home ranges of individuals in successive years are discussed, as are movements within the same season where these are of interest with respect to sites occupied in later years.

POPULATION DECREASE OF ADELIE PENGUINS *PYGOSCELIS ADELIAE* IN THE ROSS SEA SECTOR OF ANTARCTICA

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Studies on the breeding biology of the penguins *Pygoscelis adeliae* and *Aptenodytes forsteri* have shown marked numerical fluctuations in these species in the Ross Sea sector of Antarctica. These fluctuations have not only revealed nondirective oscillations as in Emperor Penguins. The breeding colonies of Adelie Penguins have continuously decreased at Cape Royds, Cape Crozier, Ross Island and Cape Hallett, Victoria Land. The breeding populations decreased between 30–50 per cent during 1961–71 and a total of approximately 100,000 breeding pairs disappeared. By comparing aerial photographs taken during the seasons 1962–63 to 1966–67 with the author's counts in the colony at Cape Crozier, it became clear that parts of a colony were specially deserted round any places of human activity. There is no direct influence, at least at the present time, on the number of Adelie Penguins of any other factor, abiotic or biotic, e.g. *Salmonella* bacteria, which have been found by the author in 1970–71 in the colonies at Capes Crozier and Royds (first records in Antarctica). For protection of penguins I suggest: monitoring size of population in colonies at different coastal regions of Antarctica, limiting human access to colonies during incubation and separating research areas and human living quarters.

EVOLUTION OF REPRODUCTIVE RATES IN THE GREAT TIT *PARUS MAJOR*

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The number of eggs laid by the Great Tit is affected by a number of phenotypic variables. When each clutch has been corrected for phenotypic variations, part of the variation in clutch-size can be shown as an inherited characteristic and apparently both mother and father contribute to the 'genotype' clutch-size in the daughter.

Recaptures of large numbers of individuals (previously ringed as nestlings) enable analysis to be made of the success of clutches of different sizes; the most productive brood-size in each year is shown in relation to the commonest clutch-size for that year. On average, the most productive brood-size is higher than that laid by the birds. Various reasons for this are discussed. The most productive brood-size in any year is correlated with the total rate of survival in that year, the higher the rate of survival of the young, the higher the most productive brood-size; reasons for this are discussed.

POPULATION BIOLOGY OF MARABOU STORKS IN UGANDA

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The Marabou Stork *Leptoptilos crumeniferus* is widely distributed in tropical Africa, specially in grasslands and near water. It is primarily a scavenger of the plains but has recently become common round human settlements. Marabous exhibit a wide range of plumages, differing with age and also within an annual cycle. A simple model of the age-structure of the population based upon data from marked individuals suggests that the average annual mortality in immatures is about 25 per cent, decreasing to less than 15 per cent for adults and producing a maximum life-span of some twelve to fourteen years.

Marabous probably start breeding at an age of 4–5 years and thereafter breed annually. They nest in colonies, usually of between twenty and 100 nests. The onset of breeding normally coincides with a marked drop in rainfall. Once started, breeding

within the colony is well synchronized and this seems to contribute to breeding success. Larger, more compact colonies are also more successful than small dispersed ones. Total success is, however, low; this seems to be characteristic of large birds in the tropics. The adaptive significance of some of these facts is briefly reviewed in relation to the general biology of the species.

THE BREEDING OF THE AUSTRALIAN WEDGE-TAILED EAGLE AQUILA AUDAX IN SEMI-ARID HABITATS

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Regular observations were made from 1967 to 1973 on populations of Wedge-tailed Eagles in two semi-arid regions of Western Australia. Mean annual rainfalls were 178 and 216 mm and were erratic within and between years, especially in the drier region.

The introduced rabbit *Oryctolagus cuniculus* was practically the only source of food in the drier region during the breeding season and probably throughout the rest of the year. Breeding depended on density of rabbits, which fluctuated very strongly because of the opposite effects of drought or rains on the growth of the grass. In extreme drought Eagles stopped breeding altogether and some left the area. Immature Eagles dispersed, for whatever reasons, up to 650 km from their natal areas in the two regions. In the second region, where rainfall was slightly higher and less erratic, the food was much more varied and rabbits were a comparatively minor component during the breeding season and probably at other times. Though maximum breeding densities were lower than the maxima in the drier region, the minima were higher.

These results indicate the greater effect of rainfall on breeding when there is only one source of food in dry areas of erratic precipitation.

A NINE-YEAR CENSUS OF BROODS OF MOUNTAIN DUCK TADORNA TADORNOIDES ON LAKES AND SWAMPS OF ROTTNEST ISLAND, WESTERN AUSTRALIA

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During nine breeding seasons (1965-73) counts of broods were made fortnightly on lakes and swamps of Rottneest Island. Arrival dates of new broods varied from 19 June to 18 October. The mean size of broods during the period was 7.49 ± 0.85 with a variation from 6.52 (S.E. 0.67) in 1972 to 8.95 (S.E. 0.55) in 1968. The mean number per brood arriving on a lake did not vary from year to year.

When a brood of ducklings were completely feathered and in the flapper stage (age 57-70 days), it was considered to have survived the brood period. In the years 1965-67 and 1969-73 205 broods (1,503 ducklings) arrived on the salt lakes, of which 1,215 (80.8 per cent) were considered to have survived. The mean size for those broods with birds reaching the surviving age was 6.58 ± 0.69 . The largest number of ducklings observed in a single brood was twenty-four.

The mortality in 1,503 ducklings was 288 (19.2 per cent) during these eight years. The highest mortality was in the first week on the brood territory with a mean mortality of $13.12 \text{ per cent} \pm 4.26 \text{ per cent}$ varying from a high of 19.32 per cent in 1972 to a low of 7.23 per cent in 1965. Interchange was noted in ten broods with an exchange of sixteen ducklings. The phenomenon appears to occur by accident or as a result of fighting by adults.

The high rate of survival in broods results in a surplus of ducks being produced every year. The mean number of pairs breeding per year during the years 1965-73 was 25.8 and the mean number of ducklings surviving per year during the same period, excluding 1968, was 151.9.

THE BREEDING PHENOLOGY OF THE ROYAL ALBATROSS DIOMEDEA EPOMOPHORA SANFORDI

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A small, unique and rigidly protected population of the Northern Royal Albatross breeds on the mainland of New Zealand at Taiaroa Head, Dunedin. Since 1937 some ninety-four chicks have been reared, with forty-four, all more than four years old, having returned to the colony. There is a short annual laying cycle within which individual females, irrespective of age and mate, have a set time for laying. Breeding adults, bereaved breeders and birds keeping company usually return by the peak of laying. Potential breeders that do not lay generally leave by the start of hatching. Non-breeding adolescents return after laying is completed and remain until after the guard stage. The youngest birds return latest and arrive progressively earlier as sexual maturity approaches. Males generally return earlier than females.

At least one year of keeping company is required before breeding. The different times of return for adolescents ensures that only potential breeders are present during laying. Sexually mature breeders are unable to breed if an age imbalance occurs. Though females may lay eggs from eight years of age, early breeding success shows that fertilization is not generally successful until the male reaches nine years. A high loss of eggs among young pairs may be because the male is inexperienced.

REPRODUCTIVE PATTERNS AND FLEDGING SUCCESS OF BIRD COMMUNITIES IN NORTH AMERICAN DESERTS

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Bird communities of about thirty species in the Sonoran Desert, the hottest and driest division of the North American Desert, have breeding phenologies closely synchronized with usually predictable bi-seasonal rainy periods. Most species concentrate nesting activity after winter rains, coincident with growth of plants and emergence of insects; they may breed well into or even throughout the hot and rainless spring. Few species nest only after summer rains have begun and all young fledge by the end of summer. Most species of nesting birds are permanent residents but about 30 per cent are seasonal migrants. About five species may be nomadic and under exceptional environmental conditions congregate locally where rainfall is favourable.

A three-year study of two adjacent communities in the Sonoran Desert coincided with unusual patterns of precipitation and reveals reproductive responses to opposite extremes of rainfall. Diversity of breeding species and density of population fluctuate annually and total biomass of all young fledged may vary by a factor of three from one year to the next. Clutch-size and fledging success are closely associated with precipitation before and during nesting. Reproductive strategies of the birds are analysed to evaluate their success in solving problems imposed by high temperatures and aridity.

BREEDING BIOLOGY OF THE SHORT-BILLED FORM OF THE WHITE-TAILED BLACK COCKATOO CALYPTORHYNCHUS BAUDINII LATIROSTRIS (CARNABY)

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Two subspecies of White-tailed Black Cockatoo, *Calyptorhynchus baudinii baudinii* and *C. b. latirostris*, occur in the south-west of Western Australia. The former is a pest of apple and pear orchards and the latter attacks pine plantations and almond trees. Both forms move away from their breeding areas during the non-breeding season and

form mixed flocks. During the breeding season nominate *baudinii* appears to be limited to the high-rainfall woodlands of the south-west, whereas *latirostris* breeds in the drier sclerophyll woodland of the inland.

Studies of marked individuals of *latirostris* show that pairs are maintained throughout the year and a bird does not change its partner unless its partner dies. Pairs return to the same area year after year although they may use different nesting hollows. Hollow trees are rather scarce and competition for hollows with Galahs *Cacatua roseicapilla*, Long-billed Corellas *Cacatua tenuirostris*, Mountain Ducks *Tadorna tadornoides* and Wood Ducks *Chenonetta jubata* occurs.

Young are fed in the nest at first only by females, then by both parents. The single nestling fledges at about 70–75 days and remains with its parents throughout the following non-breeding season. Observations of marked individuals show that the family unit may travel together long distances, before the pair return to the breeding area without their offspring. Parental attachment to young is so great that one maimed nestling was fed regularly in its nest for nearly 150 days before it finally disappeared.

EVOLUTION AND ADAPTIVE SIGNIFICANCE OF SOCIAL SYSTEMS OF STIFF-TAILED DUCKS *OXYURA* SPP IN THE NORTHERN AND SOUTHERN HEMISPHERES

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Seven taxa of stiff-tailed ducks (Tribe Oxyurini) constitute the genus *Oxyura*. Two taxa occur in the northern hemisphere, the others in the southern hemisphere. All species exhibit sexual dimorphism. Males of all species have blue beaks and chestnut-brown bodies during the breeding season. In species typical of the southern hemisphere the males have all-black heads; northern hemisphere males have areas of white on their heads. Based on a comparison of the displays of the males, the genus *Oxyura* can be divided into northern- and southern-hemisphere species-groups.

The broad features of the ecology and behaviour of the two species-groups are outlined, with attention being focused on contrasting the North American Ruddy Duck *Oxyura jamaicensis* with the southern African Maccoa Duck *Oxyura maccoa*. Differences in mating and systems of spacing are examined and are interpreted in relation to important pressures of selection that have shaped the evolution of communication and social organization in the species. Thus the adaptive significance of the distinctiveness manifest in the displays and plumages of the two species-groups can be identified.

GONADAL DEVELOPMENT AND GONADAL CONTROL AS AN ADAPTATION TO ARID HABITAT IN THE ZEBRA FINCH

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Young Australian Zebra Finches undergo very rapid sexual maturation. In more than 120 males—from the day of hatching to seventy-days old—gonadal size and spermatogenesis were investigated. By histochemical methods, the onset of testosterone-synthesis could be determined. The development of secondary sexual characters and sexual behaviour was investigated as well. In the females, follicular growth was measured. The results prove the precocity of Zebra Finches, which is more pronounced in wild strains than in domesticated ones, as was shown in former investigations. So, this precocity is caused by a natural selection pressure, probably by special climatic factors: drought and irregular rainfall. The same climatic factors also selected a particular way of gonadal control. In the males, there is no necessity for a stimulating factor to develop mature testes; even drought fails to inhibit testicular maturation.

Testes seem to undergo full maturation under all circumstances. In females, however, only the first steps of follicular growth are independent of external stimuli; full maturation is not brought about by photoperiodic stimuli, but depends on subsidiary factors.

TERRITORIAL BEHAVIOUR BY THE MALLARD ANAS PLATYRHYNCHOS ON THE CANADIAN PRAIRIES

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Marked wild Mallards were observed in pothole habitat of the Canadian prairies in Manitoba. According to Tinbergen's (1957, *Bird Study* 4: 14-27) criteria the Mallards behaved territorially: both members of a pair showed attachment to site and males were hostile toward a certain category of other Mallards. Territorial behaviour was pronounced during a brief critical period while the female was establishing her nest. The area within which a pair restricted their activity during the critical period is called an activity centre. The most frequently observed aggressive behaviour was the pursuit flight. It is a variable behavioural pattern changing with time and depending upon circumstances each time. It always involves a chasing male and the subject is either a female or both members of a pair over 98 per cent of the time. After most of the pursuits the chaser returns to the area of the origin and the chased lands elsewhere. Results indicate that the chaser expels intruders from his activity centre most effectively during the critical period of the breeding cycle. The pursuit flight thus appears to be an effective means of territorial defence.

SEASONAL AND OPPORTUNIST NESTING OF THE CORMORANT IN ETHIOPIA

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Observations on nesting of the Cormorant *Phalacrocorax carbo lucidus* were made at Lakes Shala (7°30'N, 38°30'E) and Abiata (7°35'N, 38°35'E) from 1966-73. During 1966-69 Cormorants nested at Lake Shala, mainly in April and May. Because few fish inhabit Shala, the nesting Cormorants obtained food elsewhere specially at neighbouring Lake Abiata, which has many fish. Beginning with the rains of 1967 (June), Lake Abiata's water-level increased, flooding extensive areas of acacia trees and reaching in October 1971 a peak of six metres above the level in May 1967. In December 1968, Cormorants began to nest at Abiata, using flooded acacias, and continued to do so for fifty-one consecutive months; as many as 2,500 pairs attempted to nest in 1970 and 1972. By February 1973, the water-level had fallen three metres, the acacias were no longer surrounded by water and the Cormorants stopped nesting at Abiata. With the rise in level of Abiata, nesting Cormorants became less numerous at Shala, declining from a maximum of 700-800 pairs in 1967 and 1968 to nine pairs in 1972. An available continuous supply of fish combined with the isolation afforded by flooded acacias probably accounted for the shift from seasonal nesting at Shala to continuous opportunist nesting at Abiata.

PAIR FORMATION IN THE AUSTRALIAN PELICAN

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The breeding behaviour of the Australian Pelican *Pelecanus conspicillatus* was studied between 1968 and 1971 at Lakes George and Cowal, New South Wales. Courting birds

are characterized by brightly coloured gular pouches that differ from those of non-breeding and incubating birds. Courtship takes place away from the nest in groups of walking, swimming and flying birds. The female selects the site and digs a scrape in the soil. Both birds take turns guarding the site. Copulation occurs on the site only. Both birds collect nesting material. The female, without leaving the nest, hauls material towards it. The male collects from some distance away.

Different sets of signals are used between members of a pair during courtship, selection of nest-site, copulation and relief at the nest.

CRÈCHING BEHAVIOUR OF SHELDUCK TADORNA TADORNA

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The amalgamation of broods of ducklings into crèches guarded by only one pair of adults is a common feature of the biology of Shelducks. Transfer of some or all ducklings from one brood to another was observed when two sets of parents fought with each other in defence of their brood and the ducklings were left unattended and when two broods intermingled while feeding well away from their parents. Most crèching occurred when ducklings were less than seven days old and involved 65 per cent of all broods in the study-area. Individual ducklings passed through at least three different broods and some adults reared ducklings that were not their own. Over three years of study, ducklings in crèches suffered significantly higher mortality than those reared in family broods but in the long-term survival in these two circumstances is probably similar. Crèching was considered to be the accidental result of a number of broods using a common feeding area.

COLOUR OF CERE AND THE REGULATION OF BREEDING IN THE BUDGERIGAR MELOPSITTACUS UNDULATUS

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The cere of male Budgerigars at all times is dark blue, but it is light blue in non-breeding and brown in breeding females. The change from a blue to a brown cere occurs before or during the selection of nest-holes and in the early stages of recrudescence of the oocytes and oviducts. The brown cere is maintained during the breeding cycle. The cere changes back to blue when the young are fledging or shortly after they have flown and when the regression of the oocytes and oviducts is near completion. The changes in colour are probably under the control of the sex hormones.

Budgerigars are apparently opportunistic breeders, viz they have repeated breeding cycles when the season is favourable and maintain a non-breeding state in unfavourable seasons. A model that describes how breeding may be regulated is formulated, an important part of which is the change in the colour of the cere of females. Experiments on caged birds and field observations supporting this model are presented.