

Text and images extracted from

Marchant, S. & Higgins, P.J. (co-ordinating editors) 1990. Handbook of Australian, New Zealand & Antarctic Birds. Volume 1, Ratites to ducks; Part B, Australian pelican to ducks. Melbourne, Oxford University Press. Pages 953, 1071, 1078-1087; plate 79.

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953

Order CICONIIFORMES

Medium-sized to huge, long-legged wading birds with well developed hallux or hind toe, and large bill. Variations in shape of bill used for recognition of sub-families. Despite long legs, walk rather than run and escape by flying. Five families of which three (Ardeidae, Ciconiidae, Threskiornithidae) represented in our region; others — Balaenicipitidae (Shoe-billed Stork) and Scopidae (Hammerhead) — monotypic and exclusively Ethiopian. Related to Phoenicopteriformes, which sometimes considered as belonging to same order, and, more distantly, to Anseriformes. Behavioural similarities suggest affinities also to Pelecaniformes (van Tets 1965; Meyerriecks 1966), but close relationship not supported by studies of egg-white proteins (Sibley & Ahlquist 1972). Suggested also, mainly on osteological and other anatomical characters, that Ardeidae should be placed in separate order from Ciconiidae and that Cathartidae (New World vultures) should be placed in same order as latter (Ligon 1967).

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Family PLATALEIDAE ibises, spoonbills

Medium-sized to large wading and terrestrial birds. About 30 species in about 15 genera, divided into two sub-families: ibises (*Threskiornithinae*) and spoonbills (*Plataleinae*); five species in three genera breeding in our region. Body elongated, neck long. Male larger and with longer bill than female. Wings rather long and broad; 11 primaries; p8 and p9 longest, p11 minute. About 20 secondaries; diastataxic. Fly with strong wing-beats, often soaring; neck and legs extended. Tail short, square or slightly rounded; 12 feathers. Bill long: decurved in ibises, straight with flattened end in spoonbills; nostrils slit-like. Varying extent of bare skin on head and in *Threskiornis* on head and neck. Legs rather long, lower half of tibia bare; toes of medium length, with small webs basally, hind toe or hallux slightly elevated, middle toe pectinate only in *Plegadis*. Carriage of body upright, gait striding. Oil-gland, feathered. Feathers with aftershaft. Down on feather-tracts and apteria; no powder-down patches. Plumage, white, red, red-brown or black; dark colours often glossy. Sexes alike. In some species, notably *Threskiornis* and *Platalea*, breeding plumage differs from non-breeding by occurrence of ornamental feathers. Bare parts, especially of face, coloured black, brown, red or yellow; colour may intensify during pair-formation, such as red patches under wing in *Threskiornis molucca*. Two moults per cycle; pre-breeding moult may involve only small part of plumage. Moult of primaries in staffelmauser (outwards). Young semi-altricial, nidicolous. Two downs: white, grey or black; first sparse, growing from follicles of later contour-feathers and soon overgrown by dense second down, growing from follicles of later down. Juveniles, similar to adults, but often darker with bare areas of head smaller.

Cosmopolitan in tropical, subtropical and temperate areas. Marine intertidal and inland aquatic birds of warm and temperate continental climates, preferring standing or slow-flowing fresh water, marshes, floodlands and tidal flats. Ibises feed also in drier habitats. In our region species nomadic, with wide post-fledging and post-breeding dispersal. Move diurnally; usually roost in trees and bushes over water at night; fly in formation; often soar. Eat many sorts of invertebrates, especially insects and their larvae, molluscs and crustaceans, and small vertebrates, particularly fish, reptiles and amphibians. Feed mostly in shallow wet areas where typically probe in soft mud (ibises) or sweep bill from side to side in water (spoonbills). Some ibises feed much on insects in dry habitats, often probing in cracks in soil, and on insects flushed from pastures by irrigation; scavenge at garbage tips, poultry farms and in public parks. Gregarious when foraging and when roosting at night. Typically colonial breeders, pairs defending only nest-territory. Spoonbills may nest in small groups or singly. Monogamous pair-bond, of seasonal duration so far as known. Pair-formation appears to be as in other Ciconiiformes but not widely studied; displays include similar essential elements such as Twig-grasping and Stick-passing. Voice, mainly harsh, guttural, wheezing or grunting, with some bill-snapping sounds. Vocalization most apparent during pair-formation, nest-building and nest-occupation. Away from colony or roost, generally silent except when flocks alarmed. Nestlings more vocal than adults, with shriller sound. Comfort-behaviour similar to that of other waterbirds; stand in shallow water, often rapidly beating wings; crouch on nest or roost with wings outstretched and bare patches exposed in hot weather. Heat dissipated by gaping and gular fluttering, adults and unfledged young often stand with one wing lowered; eggs and nestlings sheltered by drooping wings of adult.

Annual, seasonal breeders in temperate parts of range, with local variation influenced by rainfall and flooding. Nest in trees or dense vegetation, almost invariably over water; occasionally stumps or small islands in marshes. Colonies of ibises and spoonbills often mixed, occasionally with cormorants. Nests large, interwoven from available vegetation, usually of sticks and rushes. Built largely by female with material brought by male. Eggs oval, white and smooth, except *Plegadis* (deep greenish-blue and slightly rough). Clutch-size 2-5 (1-5). One brood. Replacement clutches after loss. Eggs laid at intervals of 1-2 days. Incubation period 21-29 days. Incubation starts with first egg; hatching asynchronous. Both sexes incubate, changing over at least once in 24 hours. Single median brood patch. Eggshells discarded over side of nest. Young cared for by both sexes; nestlings brooded continuously when small. Fed mainly by partial regurgitation. May leave nest site at 2-3 weeks, often forming crèches but returning to nest to be fed. Nestling period 4-7 weeks, young becoming independent 1-4 weeks later. Age at maturity unknown, but breeding may occur in *Threskiornis* at 18 months-2 years.

Ibis molucca Cuvier, 1829, *Règne Animal, nouv. éd.* 1: 520, note — Moluccas.

The generic name is a combination of the Greek θρησκόος (religious or sacred) and ὄρνις (bird), referring to the status of ibis among the ancient Egyptians, who regarded the birds as representing Thoth or Tehuti, the moon-deity. The specific name is for the type-locality as a noun in apposition, and ought not to be declined.

OTHER ENGLISH NAMES Sacred, Australian, White, Black-headed or Black-necked Ibis.

MONOTYPIC

FIELD IDENTIFICATION Length 65–75 cm; wing-span 110–125 cm; weight: males 1.7–2.5 kg, females 1.4–1.9 kg. A plump-bodied, mainly white ibis with very long, down-curved bill and dark hood; plumage sometimes becomes stained and dirty. Sexes similar, males generally larger but size overlaps; bill of male more robust than that of female. Juveniles and immatures separable but timing of development of these plumages appears to vary. Seasonal changes in bare parts and plumages.

DESCRIPTION ADULT BREEDING. Head and upper-neck, unfeathered, black; narrow transverse broken bands of pink to red skin on nape sometimes visible; dark head and neck contrast with mainly white upper- and underparts, wings and tail. Above folded wing-tips, tertials, lacy, conspicuously banded glossy black-and-white. Tips of primaries, glossy green-black when fresh. Stiff, pale-yellowish plumes project from base of neck. Rest of underparts, white except for patch of bare scarlet skin on outer breast continuous with tracts of bare scarlet skin on underwing, along bones of wing; visible in flight, or on ground when wings raised. In flight, looks mainly white with black tips to primaries. Iris, dark brown; sometimes shows bright-red tissue round edge of orbit. Bill, black, very long, down-curved and tapering to slender tip. Legs and feet, long and blackish, sometimes claret-red on upper tibia and tarsus. **ADULT NON-BREEDING.** Often off-white, with tertials dull grey and less lacy; neck plumes, absent. Bare skin on outer breast and under wings pink not red. **JUVENILE.** Head and upper-neck, feathered, dark with scattered white feathers; remiges have dark shafts and primaries show more extensive dark dull grey-brown tips; tertials, dull grey-brown, not lacy. **IMMATURE.** Similar to non-breeding adult but head and neck feathered, appearing spotted rather than uniformly dark, because feathering grey and white, which is gradually lost; tertials and tips of primaries, dark and dull rather than black and glossy. Third-year birds can be identified by narrow (c. 1 cm wide) collar at base of bare head and neck, which is last remaining trace of juvenile plumage and generally gone by fourth year.

SIMILAR SPECIES On ground; easily identified

from other large, mainly white, long-legged birds by dark hood and long decurved black bill, contrasting with mainly white body; other Aust. ibis are predominantly or all dark; however, flight silhouette very similar to that of **Straw-necked Ibis** *Threskiornis spinicollis* and care needed to distinguish colour in poor viewing conditions; bill of Australian White Ibis appears more prominent than that of Straw-necked. Likely to be mistaken only for **spoonbills** *Platalea* spp at a distance or in flight: bill-shape very different but not always immediately apparent in flight silhouette and care should be taken to examine bill from all angles; further, juvenile **Royal P.** *regia* and less so, **Yellow-billed P.** *flavipes* **Spoonbills** also have dark tips to outer primaries. In flight, neck extended (usually distinguishes from herons and egrets) and rate of wing-beats faster than in herons and egrets but slower than in cormorants.

Gregarious or solitary; breed colonially; flocks fly in trailing lines or chevrons. Inhabit wetlands of almost any sort, including estuaries and tidal mudflats, but also occur on pastures and drier ground, including disturbed areas round farms and suburban paddocks; also rivers and creeks in urban areas and rubbish dumps. Walk and wade slowly, probe for food very deliberately, in the ground or under water. Fly gracefully with measured wing-beats interspersed with glides; often circle over prospective feeding areas or roosts. Usually silent but give loud honking call when disturbed or in flight.

HABITAT Terrestrial wetlands, sheltered marine habitats and grasslands. Widespread in Aust. and New Guinea, with occasional influxes into NZ. Prefer feeding in shallow water over soft substrate or on muddy flats and shores; also away from wetlands, in moist grassland; often in open areas or where vegetation sparse or low. Feed in recently burnt vegetation (Jenkins 1971). Wide variety of wetland habitats used. In inland, prefer shallow swamps with abundant aquatic flora; and open fresh water (watercourses, billabongs, pools, floodwaters and lakes). Wet grasslands or agricultural land used mainly when invertebrate prey abundant. Also freshwater meadows; swamps with tall emergent vegetation

(*Eleocharis*, *Phragmites*, *Typha*, *Scirpus*, *Eragrostis*); and shallow parts of large lakes or deeper swamps, in open water or among shrubs (*Muehlenbeckia*) or trees (*Melaleuca*, *Eucalyptus*). Saline habitats regularly used; estuaries (mainly intertidal mudflats), mangrove swamps, salt pans, salt marsh, coastal lagoons and beaches (Carrick 1959; Goodrick 1970; Vestjens 1977; Corrick & Norman 1980; Corrick 1981; Gosper 1981; Corrick 1982; Fjelds  1985; Jaensch *et al.* 1988). Artificial wetlands, such as reservoirs, farm dams and sewage farms, widely used. Enter urban areas (gardens, playing fields, road verges) and scavenge at garbage tips, abattoirs, piggeries, zoos and picnic grounds (Carrick 1962; Gill 1970; Loyn 1978).

Breed in fresh, brackish or saline wetlands vegetated with reeds, shrubs or trees, in which nests are built; occasionally on bare ground or in trees away from water (Cowling & Lowe 1981; Close *et al.* 1982; Jaensch *et al.* 1988). Suggested that coastal breeding stimulated by seasonal rise in water-level (Davis & Reid 1974); but inland, breeding more extensive at swamps that have dried and refilled, producing high levels of organic matter, complex flora and diverse invertebrate population (Crome 1988).

Fly at various heights, circling in thermals to high altitude. Roost in trees, usually near water.

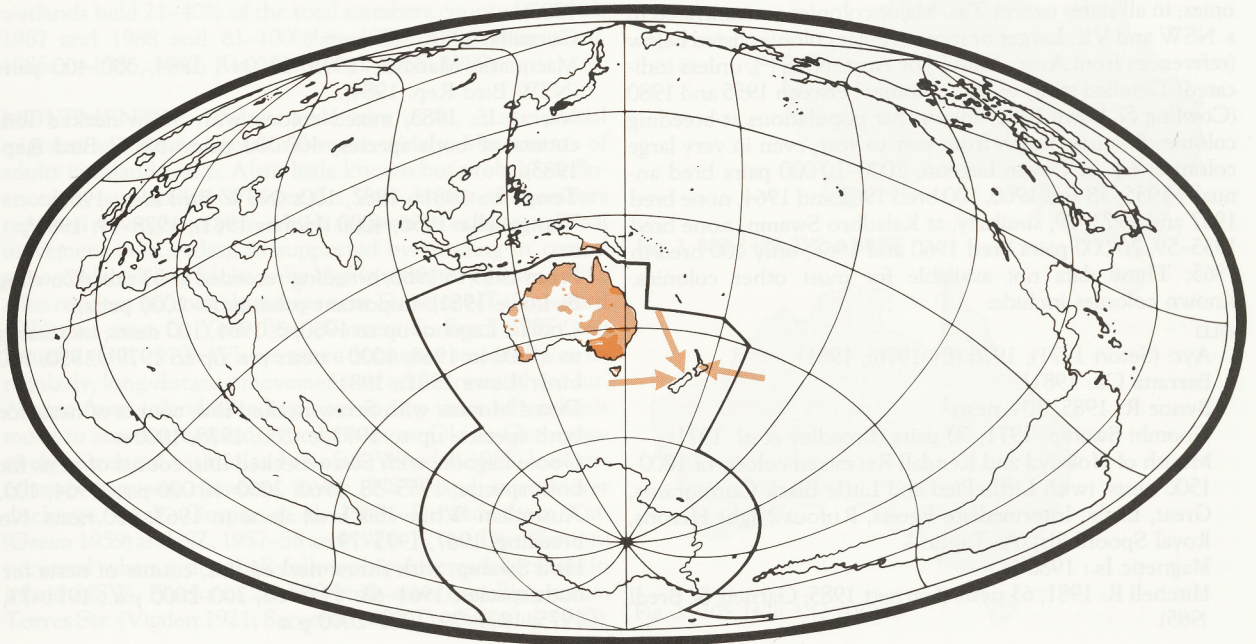
Range has expanded since European settlement (Aust. Atlas); feeding habitat has been increased by clearing of wooded areas and conversion to agricultural land and pasture (Corrick & Norman 1980); valued as consumers of introduced pests of pastures (Lowe 1981). Irrigated areas much used for breeding (Cowling & Lowe 1981). Broad tolerance of habitats and acceptance of artificial habitats reduce effects of wetland destruction, but widespread use of floodwaters for breeding threatened by damming of rivers (Carrick 1959). In Perth, WA, small numbers of birds nest in urban areas, tolerating human disturbance (Bekle 1982); nest in introduced trees; on artificial platforms at Coolart and Healesville Fauna Park and on pier on Yarra R., Vic.

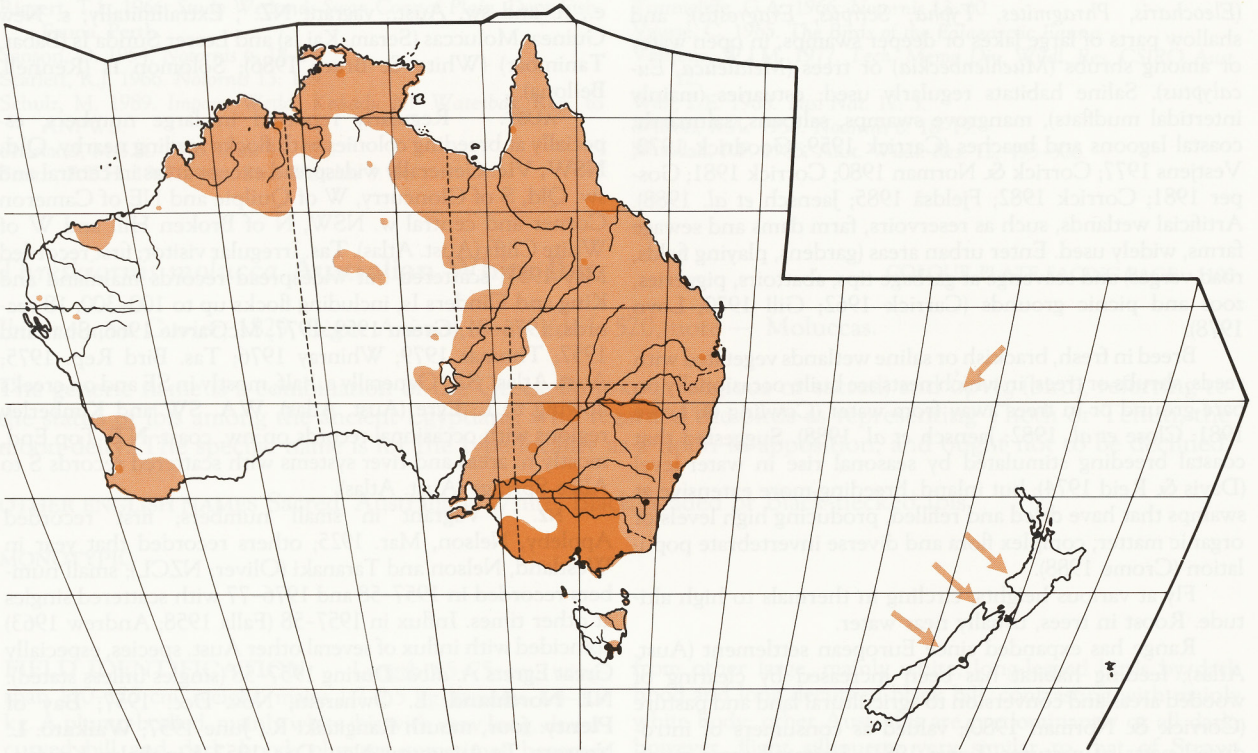
DISTRIBUTION AND POPULATION Throughout

e., n. and sw. Aust.; vagrant NZ., Extraliminally, s. New Guinea, Moluccas (Seram, Kai Is) and Lesser Sunda Is (Babar, Tanimbar) (White & Bruce 1986); Solomon Is (Rennell, Bellona).

AUST. Regularly reported in large numbers, especially at breeding colonies with flocks feeding nearby. **Qld, NSW, Vic.** Generally widespread except areas in central and sw. Qld, S of Cloncurry, W of Quilpie and NE of Cameron Corner and central w. NSW, N of Broken Hill and W of White Cliffs (Aust. Atlas). **Tas.** Irregular visitor; first recorded May 1957; scattered but widespread records mainland and King and Flinders Is, including flocks up to 100-300; 18 records, 1975-81 (Green 1959, 1977; McGarvie 1966; Sharland 1957; Thomas 1979; Whinray 1976; Tas. Bird Rep. 1975; Aust. Atlas). **SA.** Generally e. half, mostly in SE and on creeks flowing to L. Eyre (Aust. Atlas). **WA.** SW and Kimberley regions with occasional records on nw. coast. **NT.** Top End, mostly n. areas and river systems with scattered records S to Alice Springs (Aust. Atlas).

NZ. Vagrant in small numbers; first recorded Appleby, Nelson, Mar. 1925; others recorded that year in Westland, Nelson and Taranaki (Oliver; NZCL); small numbers recorded in 1957-58 and 1976-77 with scattered singles at other times. Influx in 1957-58 (Falla 1958; Andrew 1963) coincided with influx of several other Aust. species, especially Great Egrets *A. alba*. During 1957-58 (singles unless stated): **NI.** Northland: L. Owhareiti, Nov.-Dec. 1957; **Bay of Plenty:** four, mouth Rangitaiki R., June 1957; **Waikato:** L. Ngaroto, Te Awamutu, Nov.-Dec. 1957; Kinohaku, Kawhia, June 1957; **Auckland:** Kaipara, May-June. **SI.** Canterbury: Temuka Lagoons, May-Dec.; **Southland:** Invercargill; Tuatapere, 24 May 1957; Otautau, 23 May 1957; Te Tua, Te Wae Bay, 29 May 1957; Royal Bush, Aug.-14 Sept. 1957; Doubtful Sound, 12 Apr.-18 May 1957; **West Coast:** Okuru, 20 Jan. 1958; two, Hokitika, 30 Sept. 1957; two, Arahura, present till 12 July 1958. **Later records:** single, Westport, Aug., Oct., 1960 (CSN 9). Widely scattered records on NI, 1976-77 (CSN 23-25), all singles; **Northland:** Awanui, 3 Apr. 1976, Aug. 1977; Waima, Aug. 1977; L. Whangape, 4 Nov. 1976; Rangi-





puta Bank, 13 June 1976; Unahi, 23 Aug. 1976. **Bay of Plenty:** L. Wahi, 8 Jan. 1976; Maketu, June 1975–Sept. 1976, May–Aug. 1977; various estuaries and lagoons, winter 1977. **Manawatu:** Manawatu Estuary, Dec. 1976–Apr. 1977, 30 Dec. 1977–6 May 1978. **Waikato:** L. Hakanoa, near Huntley, June 1977. Since then, singles recorded Foxton No. 1, Manawatu, 6 June 1978; Awanui, Northland, winter 1979; Orowaiti, Westland, 28 Jan. 1986 (CSN 26, 28, 34).

NORFOLK I. Non-breeding vagrant, Nov. 1975 (McKean *et al.* 1976) and July 1976 (Moore 1981).

BREEDING In small to very large (20 000 pairs) colonies; in all states except Tas. Major colonies concentrated in s. NSW and Vic. Larger or more regular colonies listed below (references from Aust. Atlas [1] or Aust. NRS [2], unless indicated). Detailed study of Vic. colonies between 1955 and 1980 (Cowling & Lowe 1981) shows that populations at breeding colonies fluctuate much from year to year, even in very large colonies; e.g. at Goose Lagoon, 2000–10 000 pairs bred annually 1955–58 and 1960, 100 bred 1962 and 1964, none bred 1967 and 1973–79; similarly, at Kaladbro Swamp, none bred 1955–59, 20 000 pairs bred 1960 and 1968, only 100 bred in 1965. These data not available for most other colonies. Known colonies include:

QLD

- Ayr: (Seton 1971); 1976 (Ey 1976); 1981¹
- Barratta Ck: 1981¹.
- Bynoe R: 1985, 30+ nests².
- Goombi Swamp: 1971, 50 pairs (Broadley *et al.* 1971)
- Mouth of Holroyd and Kendall Rs: mixed colony of 1000–1500 nests, (with Little Pied and Little Black Cormorants, Great, Little, Intermediate Egrets, Rufous Night Herons, Royal Spoonbills) (A. Taplin).
- Magnetic Is.: 1980¹.
- Mitchell R: 1981, 65 nests (Garnett 1985; Garnett & Bredl 1985).

Rockhampton: 1973–74 (Longmore 1978).

NSW

- Colonies established in urban Sydney, probably all as result of expansion from introductions and releases at Taronga Zoological Gardens; breed at Royal Botanic Gardens, Centennial Park and Hyde Park (McAllan & Bruce 1988; G. Phipps; P.J. Higgins).
- Balranald: 1981, 1000 birds (Lowe 1983).
- Barrenbox Swamp: 1984, 5000+ nests (NSW Bird Rep. 1984).
- Come-by-chance: 1983, c. 500 pairs (NSW Bird Rep. 1983).
- Cornall: 1981, 200 nests¹.
- Macquarie Marshes: 1978, 2300+¹; 1984, 300–400 pairs (NSW Bird Rep. 1984).
- Narran L.: 1983, mixed colony with Straw-necked Ibis, counts of both species, 400 000 pairs (NSW Bird Rep. 1983).
- Tongo L.: 1981¹; 1982, 100s (NSW Bird Rep. 1982).
- Wanganella: 1956, 4000 (Hobbs 1961); 1978–79; 1981¹.

VIC.:

- From 1955 to 1980, breeding recorded at 53 sites (Cowling & Lowe 1981). Important colonies (>1000 pairs):
- Coolart Lagoon: up to 1960, 0; 1961, 100 nests, increasing to c. 600 in 1963; 1000+ nests p.a. up to 1979¹; 1980, 700 birds (Lowe 1981); 1981¹.
- Dowd Morass: with Straw-necked Ibis, counts of nests for both species; up to 1977, c. 200; 1978, 1000+.
- Goose Lagoon: with Straw-necked Ibis, counts of nests for both species; 1955–58, 1960, 2000–10 000 p.a.; 1964, 100. Australian White Ibis bred alone in 1962, 100 nests. No breeding; 1967, 1973–79.
- Hird Swamp: with Straw-necked Ibis, counts of nests for both species; 1961–63, 1965–66, 200–2000 p.a.; 1971–73, 1975; 1977–79, 1000–2000 p.a.

Kaladbro Swamp: with Straw-necked Ibis: counts of nests for both species; 1960, 20 000+; 1965, c. 100; 1968, 10 000+.

Kow Swamp: 1955-56, 1959-61, c. 200 nests p.a.; 1964, c. 1000 nests; 1968, <100 nests; 1969, 1979, c. 100 nests; 1978, 0.

McLeod Morass: with Straw-necked Ibis, counts of nests for both species; 1966-67, c. 200 nests p.a.; 1968, 0; 1969, 1978, c. 2000 nests; 1979, 0.

Reedy Swamp, Geelong: 1955-69, 0 p.a.; 1970-71, c. 100 nests p.a.; 1972-73, 1977, 100 nests; 1978, 1000+ nests; 1979, 500+ nests; 1983, 500 birds.

Second Reedy L.: with Straw-necked Ibis, counts of nests for both species; 1958-65, 200-1000 p.a.; 1971-73, 1979, 1000+. Australian White Ibis bred alone in 1977-78, c. 1000 nests.

SA

Bool Lagoon: 1978, 60 nests¹

Hindmarsh: with Straw-necked Ibis, counts of birds for both species; 1965, 8000+ (SA Bird Rep. 1965).

L. Alexandrina: 1964, 100+ nests².

Millicent: 1977; 1981¹.

WA

Capel: 1979, 15-20 birds¹.

Fitzroy R.: 1980, large numbers (Storr 1980).

Kununurra: 1981¹.

Ord R.: 1980, large numbers (Storr 1980).

Sturt Ck Homestead¹.

NT

Cannon Hill: 1978¹.

Coopers Ck, E. Alligator R.: 1978¹.

Kapalga, S. Alligator R.: 1980; 1981, 184 nests².

POPULATION Estimated at least 39 100 adults breeding in 16 Victorian colonies in 1979 (Cowling & Lowe 1981). Annual indices of abundance from aerial survey (transect counts) of wetlands in about 12% of land area of e. Aust., 1983-88 were 22 036; 12 047; 3327; 24 406; 4152; 6940 respectively. Wetlands round confluence of Lachlan and Murrumbidgee Rs were important areas in these surveys; these wetlands held 21-40% of the total numbers counted in 1983, 1987 and 1988 and 81-100% in 1986 (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989).

MOVEMENTS Adults sedentary in se. Aust., partial migrants sw. Aust.; immatures move widely. Movements of adults in inland and n. Aust. little known but probably influenced by availability of water. In Vic., consistent numbers reported throughout year, which suggests no regular seasonal movement (Vic. Atlas), as supported by banding in coastal areas, which shows adults to be highly sedentary (Lowe 1984). Also resident on coastal swamps near Darwin, NT (Crawford 1972), w. coast C. York Pen. (Garnett & Bredl 1985) and Innisfail (Gill 1970). Where water fluctuates seasonally or irregularly, long-distance movements of adults certainly occur. Absent from inland breeding sites in dry years when birds move to coast or beyond. Numbers in se. Qld in Oct. negatively correlated with inland rainfall (Woodall 1985) but correlation between numbers in ne. NSW and inland-river discharge, weak (Gosper *et al.* 1983). Records from Tas. (Green 1959) and NZ, 1957-58 and 1976-77 (see Distribution) occurred when a dry spell followed widespread flooding in inland NSW. Flocks of 20-500 birds seen travelling across Torres Str. (Vigden 1921; Serventy 1951; Draffan *et al.* 1983),

moving N, Mar.-Apr. at start of annual dry season, moving S, Nov.-Dec. at its end, possibly from ephemeral swamps on C. York Pen. (S.T. Garnett); birds may also move to Atherton Tableland in dry season where mostly absent Dec.-Mar. (Bravery 1970). In sw. Aust., movement apparently N in winter, returning S in summer (Bekle 1982), having first reached region after irruption in 1952 after dry weather inland (Serventy 1953).

Immatures banded coastal se. Aust. disperse E along coast, then N as far as PNG (Purchase 1976), birds from inland sites disperse along rivers, meeting N movement of coastal birds in ne. NSW (Carrick 1962). Some juveniles return to or remain near natal colony (Lowe 1984); about one-third of chicks banded at Healesville in 1981 and 1982 were seen again there during 1983-87 after periods of absence (M. Beilharz). A flock of 40 that reached Tas. were all immatures (Newman 1976), which suggests that other vagrants may have been young birds. The numbers congregating in Alligator Rs region during dry season (Morton *et al.* 1989) may also consist partly of immatures from se. Aust.

BANDING Returns (all ABBBS) from sw. Vic. summarized Fig. 1; from Westernport, s. Vic., Fig. 2; from sw. NSW, Fig. 3; from nw. NSW.

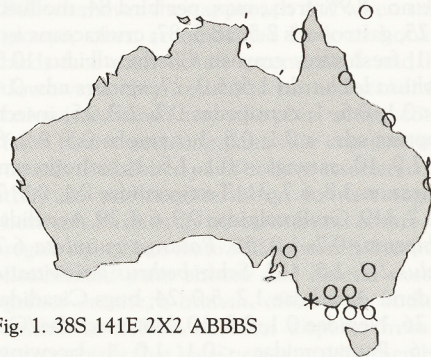


Fig. 1. 38S 141E 2X2 ABBBS

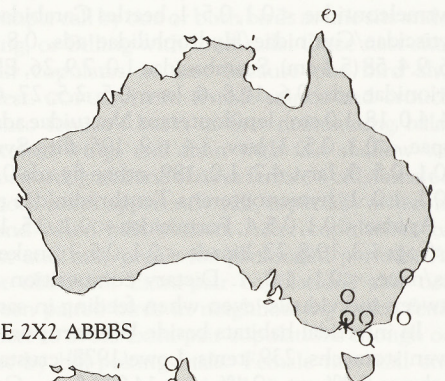


Fig. 2. 38S 145E 2X2 ABBBS

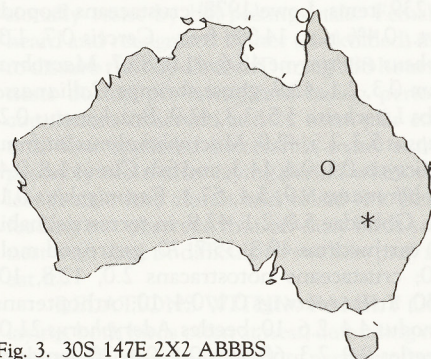


Fig. 3. 30S 147E 2X2 ABBBS

FOOD Small, usually aquatic animals including fish, frogs, freshwater crayfish, crickets, beetles and earthworms and, occasionally, snakes, diet depending largely on habitat; also take carrion. **BEHAVIOUR.** Walk slowly, using long curved bill to probe substrate or to peck food from surface of both land and shallow water. Both shallow- and deep-probing employed either when standing still or when walking slowly. Feeding methods vary with substrate, probing occurring on muddy habitat, pecking more important in pasture. Visible prey pursued and seized and will steal food from conspecifics. Most food detected by mechanoreceptors in tip of bill (Lowe 1978), large gape allowing ingestion of large items; occasionally appears to find food by stepping on it (Vestjens 1973). Prey usually crushed in tip of bill, sometimes several times, then transferred rapidly from bill to throat (Lowe 1978). Freshwater mussels sometimes carried to anvils (small flat rocks, fallen trees) either in bill or in neck after swallowing, placed on surface (sometimes after regurgitation), held by foot and smashed open with blows from bill (Vestjens 1973).

ADULT At numerous sites **between n. Vic. and s. Qld** (202 stomachs, 7712 items; Carrick 1959) major dietary components by wt. probably frogs, fish, freshwater crayfish, beetles, crickets and grasshoppers. Complete analysis: earthworms 3.5% no., 8.9% freq., max. per bird 84, molluscs bivalves 0.4, 2.5, 25, gastropods 2.5, 18.3, 87; crustaceans isopods <0.1, 1.0, 1, freshwater crayfish *Cherax albidus* 10.5, 66.3, 25, *Paratelphusa leichardti* 1.5, 5.0, 27; spiders ads. 0.4, 6.9, 7, egg-sacs <0.1, 0.5, 1; centipedes 0.2, 2.0, 15; insects odonatan Anisoptera ads. <0.1, 0.5, 1, nymphs 0.5, 9.9, 8; cockroaches 0.2, 2.0, 10; earwigs <0.1, 2.5, 1; orthopterans *Phaenocarpa vittatum* 3.8, 6.7, 31, Tettigoniidae 0.1, 0.5, 7, Gryllidae 48.8, 32.7, 319, Gryllotalpidae 0.9, 6.4, 29, Acrididae *Brachyexarna lobipennis* 0.7, 1.0, 50, *Patanga guttulosa* 6.7, 11.9, 86, *Praxibulus* 2.7, 2.0, 182, *Schizobothrus flavovittatus* <0.1, 1.0, 1, unident. Acrididae 1.2, 5.0, 24; bugs Cicadidae nymphs 0.3, 0.5, 26, Nepidae 0.1, 0.5, 10, Notonectidae/Corixidae 0.4, 9.9, 6, Pentatomidae <0.1, 1.0, 1; lacewings Myrmeleontidae <0.1, 0.5, 1; beetles Carabidae 1.9, 28.7, 18, Dytiscidae/Gyrinidae/Hydrophilidae ads. 0.8, 17.3, 9, larv. 1.6, 9.4, 58 (5.1 cm), Scarabaeidae 1.0, 7.9, 26, Elateridae/Tenebrionidae ads. 0.6, 16.8, 6, larv. 0.5, 2.5, 27, Curculionidae 0.4, 4.0, 18 (1.0 cm); lepidopterans Noctuidae ads. <0.1, 0.5, 1, pupae <0.1, 0.5, 3, larv. 3.4, 6.9, 195; flies Syrphidae pupae <0.1, 0.5, 3, larv. 4.7, 1.0, 189, other fly ads 0.1, 3.5, 4, larv. <0.1, 1.0, 1; hymenopterans Tenthredinidae pupae 0.3, 1.5, 18, Apidae <0.1, 0.5, 1, Formicidae <0.1, 0.5, 1; fish 0.9, 12.4, 10; frogs 1.3, 19.8, 22; lizards <0.1, 0.5, 1; snakes <0.1, 0.5, 1; rats/mice <0.1, 1.0, 1. Dietary composition varied greatly between individuals, even when feeding in same flock.

In intertidal habitats beside **Westernport Bay, se. Vic.** (seven stomachs, 239 items; Lowe 1978) crustaceans isopods *Crabzyos* 0.3% wt., 0.4% no., 14.3% freq., *Cercois* 0.7, 1.3, 28.6, shrimps *Alpheus euprosyne* 48.6, 41.0, 85.7, *Macrobrachium intermedium* 0.3, 2.1, 42.9, ghost shrimps *Callinassana* 0.1, 0.4, 14.3, crabs *Litochelona* 5.5, 3.3, 42.9, *Brachynotus* 0.2, 1.3, 42.9, *Paragrapsus* 5.3, 2.5, 42.9, *Macrophthalmus latifrons* 22.2, 38.9, 71.4, *Mictyris* 0.1, 0.4, 14.3, and fish *Clinus* 1.8, 0.4, 14.3, *Arenigobius bifrenatus* 9.9, 5.4, 57.1, *Favonigobius* 0.1, 0.4, 14.3, unident. Gobiidae 5.0, 2.1, 42.9; in terrestrial habitats (10 stomachs) earthworms 49.8, 35.7, 70; gastropod molluscs 5.7, 7.1, 30; crustaceans notostracans 2.0, 12.8, 10, isopods 0.4, 2.6, 30; insects earwigs 0.1, 0.4, 10; orthopterans *Teleogryllus commodus* 4.4, 2.6, 10; beetles *Adoryphorus* 21.0, 25.4, 80, other beetles 0.9, 2.3, 60; flies 0.1, 0.4, 20, lepidop-

terans Noctuidae larv. 16.2, 12.2, 80.

In **sw. NSW** (three stomachs, 112 items; McKeown 1934) crustaceans freshwater crayfish *Cherax bicarinatus* whole 21.4% no., 67% freq., partially digested 3.6, 33; insects odonatan Anisoptera larv. 0.9, 33, beetles *Hydrophilus* 0.9, 33, *Phalidura* 0.9, 33; a small mammal 0.9, 33. At **L. Cowal, NSW** (17 stomachs; Vestjens 1977) freshwater mussels 29% freq., freshwater snails 24, crustaceans freshwater crayfish 53, centipedes 6, spiders 18, dragonfly ads. 6, nymphs 6, earwigs 16, long-horned grasshoppers 12, leafhoppers 6, water-boatmen 6, water scorpions 6, water bugs 24, ground beetles 41, water-beetle ads. 76, larv. 24, chafer ads. 47, larv 6, click beetles 6, jewel beetles 6, tenebrio beetles 6, weevils 12, fly ads. 6, larv. 6, wasps 6, ants 6, fish *Gambusia affinis* 47, *Perca fluviatilis* 6; frogs 24; snake *Notechis scutellatus* 6. At **L. Cowal**, mussels may be seasonally important (Vestjens 1973). Also recorded taking molluscs shellfish (Mathews 1910); crustaceans crabs Grapsidae (Cleland 1912; Cleland *et al.* 1918); insects dragonflies (Jarvis 1929), orthopterans *Chortoicetes terminifera*, (Cowling 1974), bugs *Diplonychus rusticus* (Barker & Vestjens 1989), beetles cockchafer grubs (Cole 1963), *Geoscaptus laevissimus*, *Homeodytes scutellaris*, *Eretes sticticus*, *Aphodius howitti* larv., lepidopterans Noctuidae larv. incl. *Spodoptera* (Barker & Vestjens 1989), flies Stratiomyidae larv.; fish eels (30 cm x 5 cm; Fordyce 1973); carrion (Hobbs 1986). Locusts taken particularly when sluggish after spraying with insecticide (Cowling 1974).

NESTLING Food fed to chicks includes mice (Le Souëf 1925).

SOCIAL ORGANIZATION Studies by Beilharz (1983, 1988) and Lowe (1984); information supplied by K.W. Lowe. Gregarious throughout year; feed in flocks in terrestrial or aquatic habitats or solitarily in intertidal zones; flocks usually less than 40 birds but sometimes up to 200; sometimes with Straw-necked Ibis. Forms large flocks when flying to and from roosts. Flocks made up of mixture of ages and sexes; flocks unrelated, though independent young feed with parents for several weeks after fledging.

BONDS Serially monogamous but highly promiscuous with much extra-pair copulation, generally between neighbouring mated breeding birds though most take place after fertile period of female; promiscuous copulations infrequent between birds not already breeding. Duration of bonds varies: occasionally end immediately after copulation, others end after rearing single brood or bonds may last with pair rearing one or several broods each season for at least three years. Often renew bonds after break in which one or both partners bred with others. One instance of simultaneous polygamy involving two females. Sex-ratio 1.01: 1.00 (n=223 adults). First pairing and age of first breeding, at 3 years of age. Both parents incubate and tend young for up to 4 weeks after fledging. After 3 weeks, young begin to form crèches on nest-platform (K.W. Lowe); at Healesville, chicks remained on or near own nest and did not form crèches though grouping at edge of platform when fleeing threat; larger chicks sometimes wandered from nest but were not tolerated by neighbouring adults and were pecked. Until fledging, chicks fed on nest; after fledging, young perch in trees, assemble on ground (islands) or wander about colony.

BREEDING DISPERSION Colonial; up to 15 000 nests in colony (Cowling & Lowe 1981). Individual nests may touch, forming nest-platform in tree or completely covering small islands; density c. 5 nests/m² (see Breeding). Territorial;

defend nest-site and immediate surrounds; more tolerant of breeding neighbours close by than intruders. Do not defend feeding territories; aggression within feeding flocks probably disputes over food.

ROOSTING Communal; both sexes (sometimes in pairs) and all ages together. Nocturnal roosts in trees on sea-shore or over water in freshwater marshes, near rivers; often at breeding sites throughout year and associated with other ibises, spoonbills, egrets and darters (Bekle 1982). Sometimes roost during day in trees; occasionally diurnal loafing at farm ponds, on rocky headlands, mangroves on sea-shore, on islands or near shore of marshes, lakes, rivers. Before breeding season, pairs may roost together at night but away from nest-site; roost at nest-site a few days before laying, after building begins, and during laying. During incubation and brooding only one member of pair roosts on nest, other often in nearby tree with other birds. Outward flight from roosts begins at sunrise (Bekle 1982); at Coolart Lagoon, Vic., flocks tend to roost at dusk in winter and spring, and in summer arrive before dusk and feed at lagoon before roosting (Davis & Reid 1974).

SOCIAL BEHAVIOUR Studies by Beilharz (1983) and Lowe (1984) who supplied all information.

AGONISTIC BEHAVIOUR Within feeding flocks, short low-intensity interactions occur, usually a peck, which may or may not make contact; retaliation rare; occurs when birds squabble over food, especially when item cannot be swallowed whole; occasionally when disputing access to good feeding site (e.g. at garbage tips). Study of marked individuals at Healesville Sanctuary (Beilharz 1983) showed **Hierarchy of Dominance** among males contesting for food at regular feeding sites. Males dominate females but more tolerant of females than other males; not known if hierarchy among females. Threats and fights of short duration occur during assembly at roosts, especially just before breeding; also during courtship and pair-formation, and when nests being established; both sexes defend nest-site and access to mate. **THREAT**: raise head and bill (sometimes open) towards opponent, wings held open or closed, sometimes crouching; may rush at opponent lunging with bill and calling; intergrades with Advertising displays. **FIGHTS**, usually simply **Bill-poking** and **Grappling** or pushing with body and bill, particularly to back of neck, occur between both sexes, males usually fighting with other males and female with female. Fights occur when male interrupts display of another, when single males or females try to approach birds already associated or paired with another, or, after pair-formation, over ownership of nest-sites. In courting groups, fighting (and courtship) often halts at one site, group disperses, then reforms at new site where fighting and courtship begin again. When paired, both sexes may fight to defend nest-site, though male does most fighting, and female often stands under male's neck and chest. Often when females fight for access to males, interloping female has bred with male previously; fights take place when resident female returns to nest to find interloping female with her mate; male usually not involved in these fights but will often greet interloping female with billing if mate absent. Both sexes **ESCAPE** agonistic interactions by walking or flying away. No submissive posture. When attacked by other Ibis, chicks crouch down and give alarm calls but may defend themselves against much larger birds (e.g. juveniles) by pecking back. When severely attacked, nestlings lie immobile. Adults respond to people near nest by calling loudly (in groups) and standing erect with

neck and head outstretched and upwards. To escape people or avian predators, adults leave nest; young chicks crouch immobile in nest; older chicks climb up nesting tree or jump from nest into water (when older) to escape.

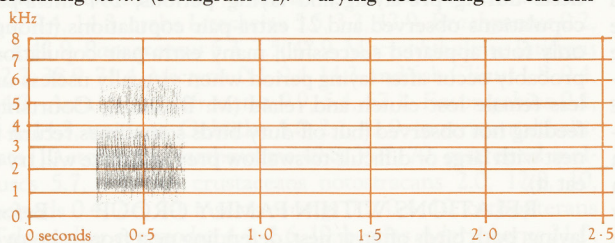
SEXUAL BEHAVIOUR **COURTSHIP**. At beginning of breeding season, males and, later, females gather in groups in trees or on islands within colony. In these groups, males **ADVERTISE** by *honking*, spreading wings out and downwards, primaries drooping with black tips visible, and fluffing feathers; on ground, males strut with head outstretched and held low, wings held out from sides, primaries sometimes drooped and feathers fluffed up, particularly neck and tertials; often run at other males in this posture (see Threat). Within courting groups, either sex may start display by joining another bird on a branch though sometimes solitary birds display; refusal or rebuff, and subsequent chasing or attack, after these approaches, rare. Usually approached bird will greet the other by **Billing**: birds stand side-by-side facing the same way, rub sides of heads and bills together and give Gurgling call (see Voice) or face each other and loosely touch and shake partner's bill. Pair may separate soon afterwards and may or may not reform. Prospective pairs usually take part in a number of courting groups each day over a period of days or weeks; they **Bill** whenever they approach and when standing together in groups; often accompanied by loud honking and **Bowing**: birds face each other, extend neck and head forward and downward, then return to normal standing position. Copulation (see below) may take place within courting group, away from future nest-site; pairs that copulate in these groups are usually established pairs or have associated previously, though they do not necessarily go to nest together. Copulation between birds with no association is rare. Females trying to regain a previous mate will approach that male for copulation. Established pairs choose and defend nest-site, standing together on site, a branch, often with bodies touching. Birds unable to defend nest-site disperse from courting groups, leaving birds that have nest-site, who then breed. **GREETING** at nest may be simple call by one or both birds as one sits and one stands, Bowing, or Billing with loud calls. Once nest-site established, pair copulates at nest because one bird always remains at nest. **COPULATION**: female stands and crouches, male steps onto female's back, at first maintaining balance with outstretched wings and then with fast shallow wing-beats, leans forward, grabs and shakes female's bill; female also shakes bill; both sexes apparently call, especially when male flaps wings and when bills shaken. After copulation, birds stand on nest and may preen for prolonged periods. Allopreening not observed. Extra-pair copulations also occur, usually between paired birds in neighbouring nests; females never leave nest to avoid extra-pair copulations though occasionally resist by bill-poking male. Female may call and if heard and recognized by her (cuckolded) mate he may return to disturb the copulation. During 588 hours of observations at nests during pre-laying and laying periods, 297 intra-pair copulations observed and 21 extra-pair copulations (though only four appeared successful); many extra-pair copulations probably occur after laying period when virtually useless unless female lost clutch and relaid (M. Beilharz). Courtship-feeding not observed (but off-duty birds sometimes return to nest with large or difficult-to-swallow prey and mate will try to eat it).

RELATIONS WITHIN FAMILY GROUP Before laying, both birds often at nest, defending nest from take-over and usually standing. Off-duty partner often returns, bringing

nesting material but does not relieve attending bird. After laying, usually only one bird at nest, incubating, except on very hot days. During incubation, relieving bird stands on edge of nest and greets sitting bird; occasionally brings nesting material and presents it to sitting bird to incorporate into nest. Sitting bird leaves, flies to nearby branch, preens, then leaves to feed. Relieving bird moves onto nest, stands for one or two minutes, fluffs out feathers then squats to incubate. Change-overs occur at any time of day (Davis & Reid 1974). Parents spend equal amount of time tending young. Chicks fed by incomplete-regurgitation; on average 3.9 feeds/h, with a burst of feeding after change-overs. Mean feeding rate in each bout for females and males not significantly different: females 0.22 feeds/min (0.36; 62), males 0.14 (0.18; 62). Adults returning to colony after foraging, land and locate young by calling. Young beg continuously for long periods and free-flying young may chase or follow adult round and out of colony, continuing to beg when they land; large young sometimes peck parent very hard on head if parent avoiding feeding them; adult does not retaliate but may leave. Parents and young appear to recognize each other visually and aurally as adults recognize and feed own young and young usually beg only from own parents. One example of female with brood of three, twice seen feeding apparently unrelated and abandoned chick of similar age to her brood. Siblings may snuggle together with other similar aged young and group together on nest-platforms when fleeing threat; no obvious communication between siblings. On nest, chicks sometimes pecked by adults, juveniles and other nestlings (see Agonistic Behaviour). After 3 weeks, young no longer attended full-time and parents spend less and less time at nest. Young remain on nest and are fed there by parents. Said to form crèches on nesting platform at this age though this was not observed at Healesville and chicks remained on nest till fledging. After fledging, young perch in trees, assemble on ground (islands) or wander about colony and wait for adults to return to feed them; may remain stationary for long periods. Period of dependence after first flight 21.5 days (13.9; 86; excluding chicks last seen fed on the day of fledging) though longest period between fledging and last feeding after fledging was 71 days. No differences in duration of feeding after fledging between male and female parents.

VOICE No detailed studies; information supplied by K.W. Lowe. Usually silent; noisy at breeding colonies and night roosts. Birds give a few varying harsh guttural croaks or honks; similar to calls of Straw-necked Ibis. Call most commonly during courtship, mainly at breeding colony: at nest-sites, in courting groups and in flight as greeting when returning to mate on nest; given during aggressive (especially male-male) and courtship displays; also call round feeding sites and in alarm. Sexual differences unknown. No non-vocal sounds reported.

ADULT (1) **Honk**. Described as harsh guttural croaking honk (sonagram A). Varying according to circum-



A P.J. Fullagar; Tongo, NSW, Nov. 1983; X076

stances. **Aggressive call**. Single, short honk, during aggressive interactions at or away from nest-site; often accompanied by peck at another bird. **Advertising call**. Repeated loud honks usually accompanied by bowing with feathers fluffed up; given during courtship displays. **Alarm Call**. Short, shrill honk in alarm when nests or adults feeding in wild are approached. **Greeting Call**. Type of honk, given in flight as bird returns to or on nest. (2) **Gurgling**. Undescribed gurgling sound also reported during greeting, when Billing. (3) **Searching Call**. Series of long slow honks given when adults search for free-flying offspring to feed them.

YOUNG High-pitched wailing *shree-shree-shree* when begging for food.

BREEDING Studied in detail in Vic. (Phillip I., Healesville, Mooroopna, Violet Town) by K.W. Lowe. Breed in simple pairs, colonially, associated with other ibises, cormorants, spoonbills, herons, egrets.

SEASON S. Vic.: laying June–Nov. (Healesville, May 1983–Mar. 1984); last young fledged early Jan. in n. Vic.; s. SA, Sept.–Dec. and Jan. (Close *et al.* 1982). Central NSW: nesting Sept.–Apr. (Vestjens 1977). Variations according to state of flooding or drought; breeding at particular sites not always annual.

SITE In forks and on large branches of trees; below, within and on top of canopy; in *Melaleuca*, mangrove, *Cupressus*, weeping willow *Salix*; sometimes on clumps of mistletoe on eucalyptus trees; up to 30 m from ground; also on flattened reeds, rushes, lignum, cumbungi, at or short distance above water-level; on bare ground on islands or at edge of wetland; on artificial structures (derelict pier; at Healesville, on specially made platforms, roof of aviary, in treeferns). Sometimes used year after year, usually by different pairs; new sites regularly occupied. Sites in a group selected and nests built within a few days but not synchronized between groups.

NEST, MATERIALS Platform of sticks, twigs (*Melaleuca*, eucalyptus), sometimes lined with leaves or even cellophane, paper. In colonies in swamps, made of stems of reeds, rushes, sometimes lined with waterweed. Individual nests may touch, forming nest-platform in tree or completely covering small islands; one nest-platform measured 100x5 m; within nest-platform, density of nests c. 5/m². Both sexes build; male usually collects material and brings it to female, who adds material to nest. Material broken off live and dead trees, collected on ground, pillaged from other old and new nests; in swamps, reeds and rushes pulled out, broken off. Material added throughout nesting cycle though less often late in cycle. Construction occurs for 2–3 days before laying, throughout day. Nest occasionally abandoned before completion and another built elsewhere.

EGGS Oval to elongated oval, much compressed at smaller end and even pyriform (North); coarse-grained, rough, finely pitted, not glossy; uniform dull white.

MEASUREMENTS:

Phillip I. 66.4 (0.3; 60–71; 33) x 44.0 (0.2; 41–47);

66.5 (0.3; 59–75; 133) x 43.8 (0.2; 39–49)

Coolart 66.1 (0.5; 59–78; 101) x 43.9 (0.2; 39–49);

Healesville 64.6 (0.4; 60–70; 36) x 42.4 (0.3; 40–46);

L. Cowal 66 x 45 mm (n=24; Vestjens 1977);

WEIGHTS: (<3 days after laying): 66.8 (1.4; 54–77; 20).

CLUTCH-SIZE One to six eggs recorded in nests but not all may have been completed clutches. Total records at seven Vic. colonies in six seasons: 19xC/1, 212xC/2,

625x C/3, 47x C/4, 1x C/5 = av 2.78 (2.52–3.21 in different seasons). At Healesville, mean clutch-size (1983–84 to 1986–87) was 2.69 (0.62; 1004); C/3 were 70% of clutches; clutch-size also varied significantly between years. Slight insignificant tendency for early clutches (June–July) at Healesville to be larger than later ones (Aug.–Nov.); vice versa at Green's; fortnightly average (July–Oct.) fluctuated haphazardly and significantly at Rhyll and Coolart. At Healesville, in two seasons, of 141 apparently adult females, 50 did not lay, 60 laid one clutch, 25 laid two, five laid three and one laid four. Lost clutches were replaced within 18 days; after successful fledging, next clutch started 13–100 days later. Some females reared three broods per season. Elsewhere, with shorter breeding period, only two broods possible.

LAYING At intervals of 48 h, during night-time. Large clutches (5–6) possibly laid by two females, as judged by measurements of eggs.

INCUBATION By both sexes, starting with first egg. No significant differences between sexes. Female on nest for 54% of time. Shifts of 1 min to 9 h. One adult incubated all night. **INCUBATION PERIOD:** 20–23 days, determined with 10 marked eggs. Hatching asynchronous; at Healesville, clutches hatch over average 2.7 days (2–3; 9x C/3); pipping to emergence 3–4 days.

YOUNG Semi-altricial, nidicolous. Brooded by both parents (female takes 59% of time) for c. 3 weeks from hatching; shifts of up to 5 h during daylight; brooded all night. After 3 weeks old, young left unattended; by then, active, flapping wings, jumping, clambering about, and will leave nest readily by swimming; begin to assemble into crèches on massed nesting platform. Fed by both adults by incomplete regurgitation, on average every 15 min throughout day; female feeds chicks significantly more often than males (207 h watch). During crèche-stage, young leave nest to be fed by parents only. Young defecate all over nest. **NESTLING PERIOD.** Average 48 days to final abandonment of nest (7; 20 marked chicks); however, much lower at Healesville, c. 30 days to final abandonment of nest. After fledging, young perch in trees, assemble on ground (islands) and wait for adults to come to feed them; at this stage feeding occurs only 1–2 times a day. Period of dependence after first flight average 21.5 days and then mostly leave area of colony but a few may stay for months and may even still be fed by parents occasionally.

GROWTH Weight at hatching at Healesville, 46.1 g (7.6; 33.6–70.4; 30). Elsewhere in Vic., at hatching, 55 g, then at intervals of 7 days to 28 days old: 80–220, 550–950, 800–1200, 1050–1810. Eyes closed for first few days after hatching; for first week, downy; pin-feathers on wing at end of first week, showing black tips through sheath; late in second week, sheath splits on primaries revealing black tip; in second and third weeks, down on body replaced by pin-feathers; in third week, young mobile but not very agile, will leave nest if disturbed; base of bill, pink for first 2 weeks then darkens progressively.

SUCCESS Varies annually and between localities. At Healesville, mean success from 2025 breeding attempts from 1983–84 to 1986–87 was 0.85 ± 0.98 chicks; differed significantly between years: 1983–84, 0.97 ± 1.01 ; 1984–85, 0.83 ± 0.96 ; 1985–86, 0.74 ± 0.96 ; 1986–87, 0.91 ± 1.03 ($P < 0.001$). Mean number of young fledged per successful nest 1.73 (0.67; 990); modal number was 2 young. Of all nesting attempts, 51% failed (76% of these at or before hatching). Predation negligible; starvation probably chief cause of deaths of young; the third chick usually smaller than older siblings, and

most likely to die when partial mortality of broods. Flooding and collapse of nests also probably important.

PLUMAGES Subspecies *strictipennis*

ADULT Almost all white; often soiled and stained. **HEAD AND NECK**, bare (black), extending as V (pointing downwards) to foreneck. On hindcrown and nape, transverse fissures exposing pink skin beneath, form broken patches of wart-like skin. Long (70–114 mm), stiff lanceolate cream (54) ornamental plumes surround skin of exposed foreneck and extend to base of neck, along mid-line (Fig. 5). **UPPERPARTS**,

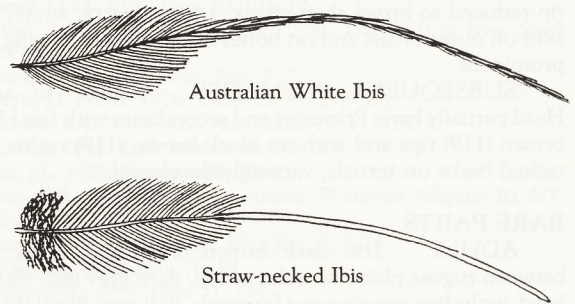


Fig. 5 Breast-feathers

mostly white; broad sub-scapulars, distally irregularly mottled, and irregularly transversely barred dark brown (221); distal third of rachis, grey-black (82); elsewhere, white. **UPPERWING.** Primaries tipped glossy black-green (162); in some lights, tips of outer webs, green (162B); size of tips, progressively smaller towards p1. Distal third of rachis on remiges, grey-black (82). S1–s13, all white; s14 mottled black-brown (119) on edge of outer web. Beginning at s15, barbs of tertials on outer webs detached from neighbouring barbs, well spaced and strongly recurved, giving lacy appearance; feathers also appear decomposed. Barbs, glossy black (89) and irregularly, transversely barred dull white; in some lights, barbs appear glossy blue-black (73). Inner webs of tertials, white and irregularly mottled and transversely barred black-brown (119). **UNDERPARTS.** Above axillaries, at humeral joint, patch of skin on outer margin of breast, bare. Feathers on flanks, elongate c. 150 mm long. **UNDERWING.** Skin along bones, bare and exposed, and continuous with bare patch on outer breast.

NESTLING Protoptile sparse. Mesoptile similar, but thicker. **HEAD AND NECK.** Down on crown, black-brown (119), thick; from crown to mid-hindneck and foreneck, brown (121), down thinner than on crown. Down sparse and short on throat. Chin, interramal space, round base of bill and eye, bare. On mid-hindneck, sharp demarcation between dark upper-neck and white lower-neck. **UPPERPARTS, UNDERPARTS.** Down, white; moderately long and thick on upperparts. Feather-sheaths, dull white. **UPPERWING, UNDERWING.** Feather-sheaths beneath primaries, dark brown (121), on upper and under wing, form small contrasting patch.

JUVENILE Almost all white. Chin, interramal space, lores, round base of bill and eye, bare. **HEAD AND NECK.** Feathered. Crown, nape and sides of head, black-brown (119). Hindcrown to mid-neck, feathers white with either shaft-streaks or tips, black-brown (119) giving streaked appearance to neck. Feathers short on foreneck. **UPPERPARTS**, white. Smaller scapulars, white; broader sub-scapulars, broadly vermiculated dark-brown (121) distally; basally white; rachis black-brown (119) for distal half of feather, sometimes dark

brown (121A). UPPERWING. Tertiaries, dark brown (221); basally white, mottled, distally, tipped white; outer webs, frayed and glossy black (89); barbs not detached from neighbouring barbs. All remiges have distal third of rachis, black-brown (119). Small shaft-streak of dark brown (221) on distal tips of secondaries. Distal edges of two outermost feathers of alula, dark brown (121); distal tips of rachis, for one-third length of feather, black-brown (119); rest of alula, white; two outermost greater primary coverts, similar; innermost, with distal third of rachis, black-brown (119) only. Primaries, tipped black-brown (119); gloss reduced; narrow to broad black-brown (119) distal edge on p10 and p9; tips smaller towards p1; at p1, tip reduced to broad shaft-streak. UNDERPARTS, white; bare skin on outer breast and on bones on underside of wing, not prominent.

SUBSEQUENT PLUMAGES Similar to adult. Head partially bare. Primaries and secondaries with few black-brown (119) tips and without black-brown (119) rachis. Detached barbs on tertiaries, varying developed.

BARE PARTS

ADULT Iris, dark brown (219). Bill, black (89); between rugose plates on sides of bill, dark grey (83). Skin of head, including eye-ring and foreneck, dull grey-black (82). At nape, fissured skin, red (10). Bare patch on outer breast, continuous with underwing, dull pink (5); during breeding, red (13). Legs and feet, black (89); upper portions of tarsus, tibia and upper toes, pink (3) with grey (84) shade.

NESTLING Iris, dark brown (119A) with light-grey (85) outer ring. Bill, pink (7); basally, dark grey (83); gradually darkens till fledging. Chin and interramal space, dark grey (83). Legs and feet, dark grey (83).

JUVENILE Iris, dark brown (119A). Bill, black-brown (119) and smooth. Bare skin at base of bill and round eye dull grey-black (82); strip of exposed skin on underwing, dark dull-pink (5).

MOULTS Largely undescribed in Aust. Based on skins at SAM, MV:

ADULT POST-BREEDING No definite period can be ascribed; breeding season can be protracted. Complete; primaries moult outwards. Body moulted shortly after completion of breeding cycle, about Dec.-Jan. in se. Aust. Duration of actual moult unknown.

ADULT PRE-BREEDING Partial; some feathers of lower neck and underparts moult; timing varies.

POST-JUVENILE Undescribed.

SUBSEQUENT MOULTS Not known.

MEASUREMENTS (1) Adult, skins (SAM, MV). (2)

Healesville Fauna Reserve, Vic., live adults; standard methods (ABBBS) (3) Vic., live birds (K.W. Lowe).

Males larger than females in all measurements; significantly in bill. No details available for growth rates of chicks.

WEIGHTS Few data. Healesville Fauna Reserve, Vic., live adults; (ABBBS): males 2005.9 (138.19; 1700-2350; 72), females 1605.9 (145.65; 1300-2120; 84); males significantly heavier. Various sites Vic., males 1950, 2030, 2250; females 1726 (68.23; 1630-1830; 8) (K.W. Lowe). No data on seasonal changes.

STRUCTURE Wing, long and narrow, slightly rounded. Eleven primaries: p9 longest, p10 18-23 mm shorter, p8 1-2, p7 4-10, p6 23-32, p5 48-58, p4 68-79, p3 84-96, p2 96-106, p1 105-119, p11 reduced, concealed under greater primary coverts. Inner web of p10-9 and outer p9-8 emarginated. Twenty secondaries, six of tertial form. Tail, rather short, nearly square; slightly forked in juveniles. Twelve rectrices, webs slightly rounded; t1 longest t6 0-6 mm shorter. Bill, long, decurved, deep at base and laterally compressed. Slit-like nostrils, situated in parallel grooves adjacent to culmen; culmen very ridged basally, shallower distally. Sides of bill with vertical transverse rugose plates; smooth in juveniles. Bill, shorter and straighter in juveniles. Head, nape and foreneck bare in adult; feathered (except for chin, interramal space, lores, round base of bill and eyes) in juvenile and immature. Bare strip of skin on underside of wing, along bones, extending to sides of outer breast. Lower half of tibia, bare. Legs, slender; feet, long. Toes, semi-palmate. Claws, rather long and pointed; slightly decurved; claw of middle toe with a few indentations. Outer toe c. 85% of middle, inner c. 71%, hind c. 44%.

GEOGRAPHICAL VARIATION Sometimes regarded as subspecies of *T. aethiopicus* (Holyoak 1970; Peters), here treated as full species (Amadon & Woolfenden 1952; White & Bruce 1986; Aust. CL; BWP). Three subspecies have been recognized: *molucca* (Moluccas, Lesser Sundas, possibly New Guinea) *strictipennis* (Aust., s. New Guinea, vagrant to NZ), *pygmaeus* (Rennell I. in Solomon Is); status of subspecies *pygmaeus* uncertain (White & Bruce 1986). Subspecies differ in size and *strictipennis* differs from *molucca* in having shafts of secondaries black, not white (Holyoak 1970). Amadon & Woolfenden (1952) state that there is a slight increase in size from N to S. Mees (1982) regards *strictipennis* as synonym of *molucca*. Forms superspecies with *T. aethiopicus*, *T. bernieri* and *T. melanocephalus* (Amadon & Woolfenden 1952; White & Bruce 1986).

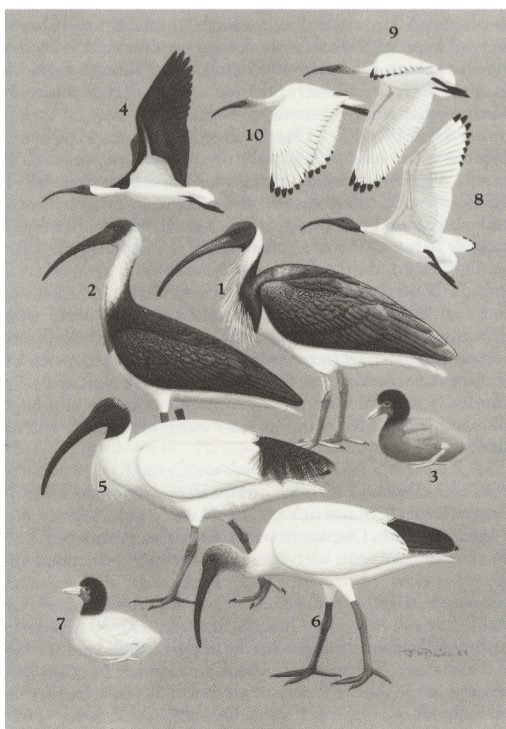
RMO

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	MALES	FEMALES
WING	(1) 380.6 (18.51; 355-398; 3) (3) 389 (7.05; 380-397; 4)	363.7 (6.64; 355-372; 4) 361 (7.88; 348-373; 12)
8TH P	(1) 228.0 (11.86; 213-242; 3)	221.5 (9.06; 210-235; 4)
BILL	(1) 188.6 (6.05; 183.5-197.1; 3) (2) 190.5 (7.22; 173-210; 78)	153.7 (4.22; 149.1-158.4; 4) 154.0 (6.71; 140-168; 86) *
TARSUS	(1) 102.7 (5.66; 94.9-108.1; 3) (3) 103 (5.92; 94-107; 4)	94.1 (1.10; 92.4-95.4; 4) 85.8 (3.39; 81.0-90.6; 12)
TAIL	(1) 126.3 (5.79; 120-134; 3)	125.0 (3.08; 122-130; 4)
TOE	(1) 94.9 (4.32; 89.5-100.1; 3)	89.2 (2.03; 87.8-92.7; 4)

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Volume 1 (Part B), Plate 79

Straw-necked Ibis *Threskiornis spinicollis*

1. Adult
2. Immature
3. Downy young
4. Adult

Australian White Ibis *Threskiornis molucca*

5. Adult
6. Immature
7. Downy young
8. Adult
9. Juvenile
10. Juvenile

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