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 terrestial birds. About 30 species in about 15 genera, divided into two subfamilies: 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 asynchronic. 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.

Threskiornis spinicollis **Straw-necked Ibis**

COLOUR PLATE FACING PAGE 1100

Ibis spinicollis Jameson, 1835, Edinb, *New Phil. J.*, 19: 213 — Murray River, New South Wales.

The specific name combines the Latin *spina* (spine, thorn) and *collum* (neck) and refers to the spiny-looking tuft of feathers on foreneck and breast.

OTHER ENGLISH NAMES Dry-weather Bird, Farmer's Friend, Letter-bird.

MONOTYPIC

FIELD IDENTIFICATION Length 60–70 cm, of which head, neck and bill nearly half; wingspan 100–120 cm; weight 1.1–1.5 kg. White-necked, black-backed ibis of grasslands and swamps. Easily distinguished from other ibises and larger waterbirds by combination of downcurved bill, blackish wings and white tail. Sexes similar; male usually larger with longer bill, often obvious in the field; female has complete dark breast band. No seasonal changes. Juvenile and immature separable.

DESCRIPTION ADULT MALE. Head and throat, bare; skin, grey-black. Conspicuous straw-like tract of yellowish spiny feathers arises from mid-foreneck below bare skin and overhangs upper breast. Rest of neck covered in dense short white feathers. Upperparts from lower hindneck, glossy blackish brown with green and purple sheen; fine horizontal barring on feathers of lower mantle, scapulars, tertials, wing-coverts and secondaries. Upperparts appear black in dull light. Rump and tail, white; obvious in flight. Underparts, white except for glossy dark-green sides of upper breast, forming incomplete breast band, partly-obscured by yellow feathers of neck. Bare patches of skin behind eye and on sides of breast beside axillaries become red during breeding. In flight: underwing mainly black; white axillaries and lesser wing-coverts form conspicuous stripe from body to carpal joint. Bill, long, heavy and downcurved; black; sides of upper mandible corrugated, ridges marked with pale olive. Iris, dark

brown. Legs, long; upper tibia shows varying extent of red or pink; otherwise black. ADULT FEMALE differs from male in having complete band of dark feathers across lower neck and upper breast. JUVENILE. Head and neck, blackish brown; feathered, except for bare patches in interramal space, on lores, and round mandibles and eyes. Some white feathering on lower neck; no yellow straw-like feathers. Upperparts less glossy and barring less pronounced than adult. No bare patches on sides of breast. Bill, short, rather straight; black with pale greyish-white tip; sides of upper mandible smoother than adult. Legs, grey-black. IMMATURE. Sides of head, throat and nape, feathered; dark brown; white bases of feathers on head and neck impart streaked appearance. A few short yellow plumes on neck; no bare patches on sides of breast. Upperparts, faintly barred. Colours of bare parts unrecorded; probably similar to adult. Lose feathers of head and throat at 3–4 years old.

SIMILAR SPECIES None, other than superficial resemblance to other ibis. Combination of dark upperparts, mostly white underparts and straw-like feathers on foreneck distinguish Straw-necked from mainly white Australian White Ibis *T. molucca* and much smaller, all-dark Glossy Ibis *Plegadis falcinellus*. In flight, Australian White Ibis distinguished by all-white underparts; Glossy Ibis by all-dark underparts.In poor light or at distance can be confused with Glossy Ibis but wing-beats slower and silhouette less attenuated.

Habitually gregarious. Typically found in fairly compact flocks feeding on wet or dry ground in grassland or cultivated land; also as loose groups in shallows or round margins of wetlands, mainly freshwater. Feed by probing into ground or vegetation with strong bill. Long-distance flights high, direct, in conspicuous V-formation or line; deep steady wing-beats broken by intermittent glides; soar high; fly with neck extended. Walk slowly with body roughly horizontal and neck fairly straight, but generally stand with neck and head retracted. Perch in bare or leafy trees. Sleep with head over shoulder and buried in mantle feathers; on ground, sit on tarsi to rest and sometimes partly extend wings. Use bill for preening, except in head and neck region which scratched with foot. Drink by scooping water up in bill and holding bill horizontal to swallow. When bathing, lower body into shallow water to immerse underparts, splash briefly, rise and shake vigorously with wings slightly raised; head bathed separately. Generally not noisy, uttering variety of croaks and grunts, but constant growling roar of calls at large breeding colonies.

HABITAT Grasslands, cultivated land, terrestrial wetlands and, rarely, sheltered marine habitats; uncommon in arid interior, though birds use permanent or ephemeral wetlands where available (Badman 1979). Feed in damp or dry grassland, often away from wetlands, or in aquatic shallows <0.25 m deep (Carrick 1959), where vegetation short or patchy enough to allow unimpeded movement. Mainly distributed away from coast; prefer pastures and cultivated land, particularly where irrigation, landform or proximity to wetlands maintain moisture content (McKilligan 1979). Wetlands used: meadows; shallow swamps with semi-aquatic herbs and abundant aquatic vegetation, or with tall emergent vegetation (*Eleocharis*, *Typha*, *Phragmites*, *Scirpus*); shallow open parts of deeper swamps, lakes and watercourses, vegetated with shrubs (*Muehlenbeckia*) or woodland (*Eucalyptus*, *Melaleuca*) (Vestjens 1977; Corrick & Norman 1980; Gosper 1981; Corrick 1982; Fjeldsa 1985; Jaensch *et al.* 1988). In n. Aust., move into open forest during wet season or after fire, but woodland with dense undergrowth avoided (Crawford 1972; McKilligan 1979). Coastal and saline habitats used occasionally; estuarine mudflats, bare saltpans, saltmarsh, coastal dunes and beaches (Corrick 1981, 1982; Gosper 1981, 1983). Enter urban areas (gardens, playing fields, street verges), and scavenge at garbage tips, abattoirs and piggeries (Carrick 1962; McKilligan 1979).

Breeding widespread in Aust., but colonies larger and more numerous S of 26°S (Aust. Atlas). Breed in fresh, brackish or saline wetlands, vegetated with reeds, shrubs or trees, in which nests are built; may nest on the ground on islands or wetland margins, especially in temporary floodwaters (Carrick 1962; Waterman *et al.* 1971; Cowling & Lowe 1981; Jaensch *et al.* 1988). In e. Aust, breeding conditions usually created by flooding, but permanent wetlands with stable water-levels also used (McKilligan 1975a); in n. Vic., irrigated areas often used (Cowling & Lowe 1981).

Fly freely up to great heights; soaring in thermals to several hundred metres (McKilligan 1975a). Roost in trees in wetlands or farmland (McKilligan 1979; Lowe 1981). In farmland, prefer roosts with enough suitable trees to accommodate whole flock and near water for drinking; when conditions cold and windy, need for sheltered position determines choice of roost-site (McKilligan 1979).

Aust. range has increased (Aust. Atlas); has benefited from clearing of wooded areas, conversion to pasture and cropland, irrigation schemes and construction of impoundments; however, birds use pasture for feeding only where stands of woodland for roosting remain uncleared (McKilligan 1979). Valued as consumers of pests in pastures, although largely ineffective in controlling plagues of locusts (Carrick 1959; Lowe 1981). Many natural freshwater wetlands used for breeding destroyed or modified by clearing, grazing, burning, increased salinity, groundwater extraction and invasion by introduced plants (Riggert 1966; Goodrick 1970; Waterman *et al.* 1971; Corrick & Norman 1980; Corrick 1981, 1982; Jaensch *et al.* 1988; Schulz 1989), and widespread use of temporary waters threatened by flood-mitigation works (Carrick 1959; McKilligan 1979).

DISTRIBUTION AND POPULATION Endemic to Aust.; not recorded NZ. In New Guinea: regular, Bensbach River area and Kurik; vagrant elsewhere (Coates 1985).

AUST. Generally widespread and to be expected in all mainland areas, except driest central and w. districts S of about 20°S and between longitudes 121°E and 136°E, where apparently rare, sporadic or absent, probably depending on wetness of season. Occasional in Tas. and on islands of Bass Str. (Green 1977) where first recorded in 1895 (North).

NORFOLK I. Vagrant, first recorded 1961 (Wakelin 1968).

LORD HOWE I. Vagrant. One present, 1971–73 (NSW Bird Reps 1971–73).

BREEDING Stronghold SE of line roughly from about Rockhampton, Qld, to mouth of Murray R., SA, with greatest concentration of colonies in Vic. and Murray-Darling drainage area of NSW and Vic. Some very large mixed colonies with Australian White Ibis reported: 400 000 pairs (both species), Narran L., NSW, 1983 (NSW Bird Rep. 1983). In WA, most colonies in coastal belt, from near Busselton to Pt. Cloates on central w. coast; one record inland, Wooleen near Murchison R. (Serventy & Whittell 1976; Jaensch *et al.* 1988; Aust. Atlas). Attempted to breed at Adelaide R., Brunette

Downs and Newcastle Waters, NT (Frith & Davies 1961; McKilligan 1975a,b). Populations at breeding colonies fluctuate much from year to year, even in very large colonies (Cowling & Lowe 1981).

Major known breeding colonies are:

QLD: breeding recorded at Duaringa, Ipswich, L. Bullawarra,

Eulo, Bowen, Brandon, Durham Downs Stn, Clonagh (McKilligan 1975a; Aust. Atlas; Aust. NRS).

NSW. Important colonies (>5000 pairs):

Balranald: 1981, 40 000 birds (Lowe 1983).

Booligal: 1984, 80 000 pairs (NSW Bird Rep. 1984); 1985, 20 000 pairs (Aust. NRS).

L. Cowal: 1964, 10 000 nests; 1985, 1000+ nests (Aust. NRS).

Littlewood Homestead: 1984, 20 000 pairs (NSW Bird Rep. 1984).

Macquarie Marshes: 1978, three colonies, 12 800 pairs (NSW Bird Rep. 1978).

Narran L.: 1983.

Tongo L.: 1982, 14 000 pairs (NSW Bird Rep. 1982).

Wanganella: 1956, 2 sites, 66 000 pairs (Hobbs 1961); 1981 (Aust. Atlas).

Yanco Ck: 1913, 15 000–20 000 birds (McKilligan 1975a).

VIC.: From 1955 to 1980, breeding recorded at 35 sites (Cowling & Lowe 1981). Important colonies (>5000 pairs):

Goose Lagoon: mixed colony with Australian White Ibis. Counts of nests of both species, *c.* 95% Straw-necked (S.J. Cowling): 1955–60, 2000–10 000 p.a.; 1964, 100. Straw-necked Ibis did not breed in 1962, 1967 or 1973–79 (Cowling & Lowe 1981).

Kaladbro Swamp: mixed colony with Australian White Ibis. Counts of nests of both species, *c.* 50% Straw-necked (S.J. Cowling): 1958–59, no breeding; 1960, 20 000+ nests; 1965, 100 nests; 1968, 10 000+ nests (Cowling & Lowe 1981). Straw-necked Ibis bred alone in 1963, 100 nests.

Reedy Swamp, Geelong: 1955–73, no breeding; 1976, 1000 nests; 1977–79, 10 000+ nests p.a. (Cowling & Lowe 1981).

Vaughan I.: 1959, 1961–64, 200 nests p.a.; 1969–70; 1971–72, 10 000+ nests; 1973–74 (Cowling & Lowe 1981)

Wool Wool Rocks: 1967–68, 1971–78, no breeding; 1979, 10 000+ nests (Cowling & Lowe 1981).

Second Reedy Lake: 1979, 10 000+ nests (Aust. NRS).

Hird Swamp: 1979, 10 000 nests; 1981, 10 000 nests (Aust. NRS).

SA. Important colonies (>5000 pairs):

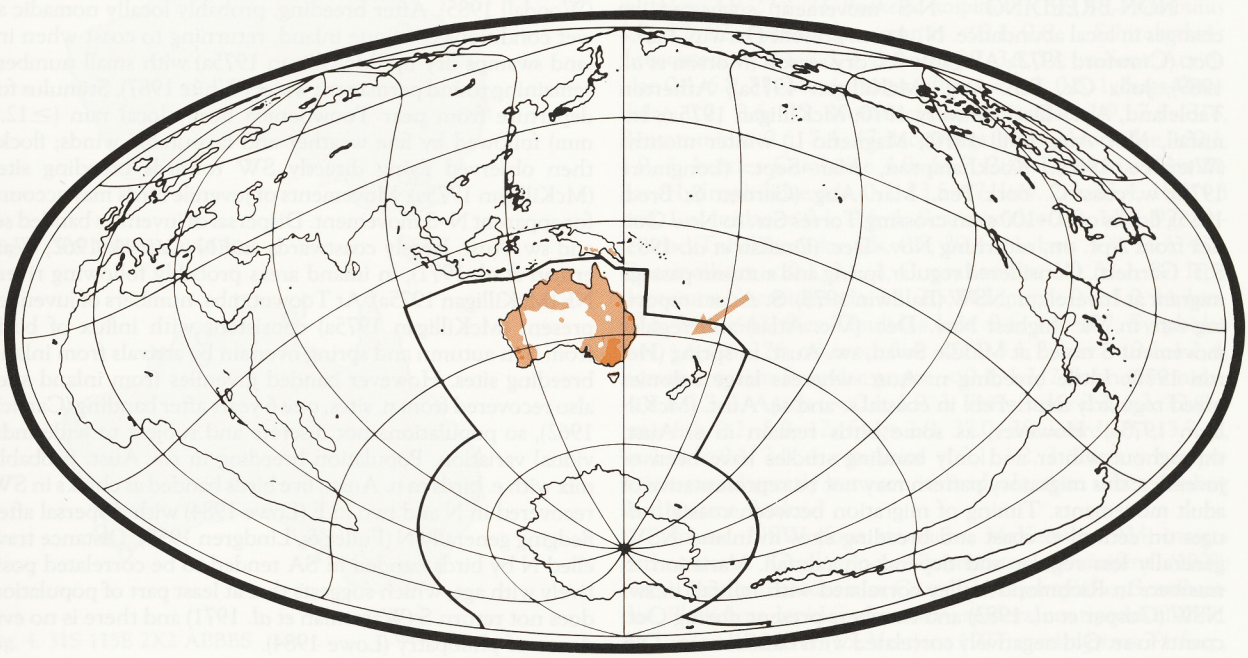
Bool Lagoon: 1963, 150 000 nests (Waterman *et al.* 1971); 1978; 1979 (Aust. Atlas).

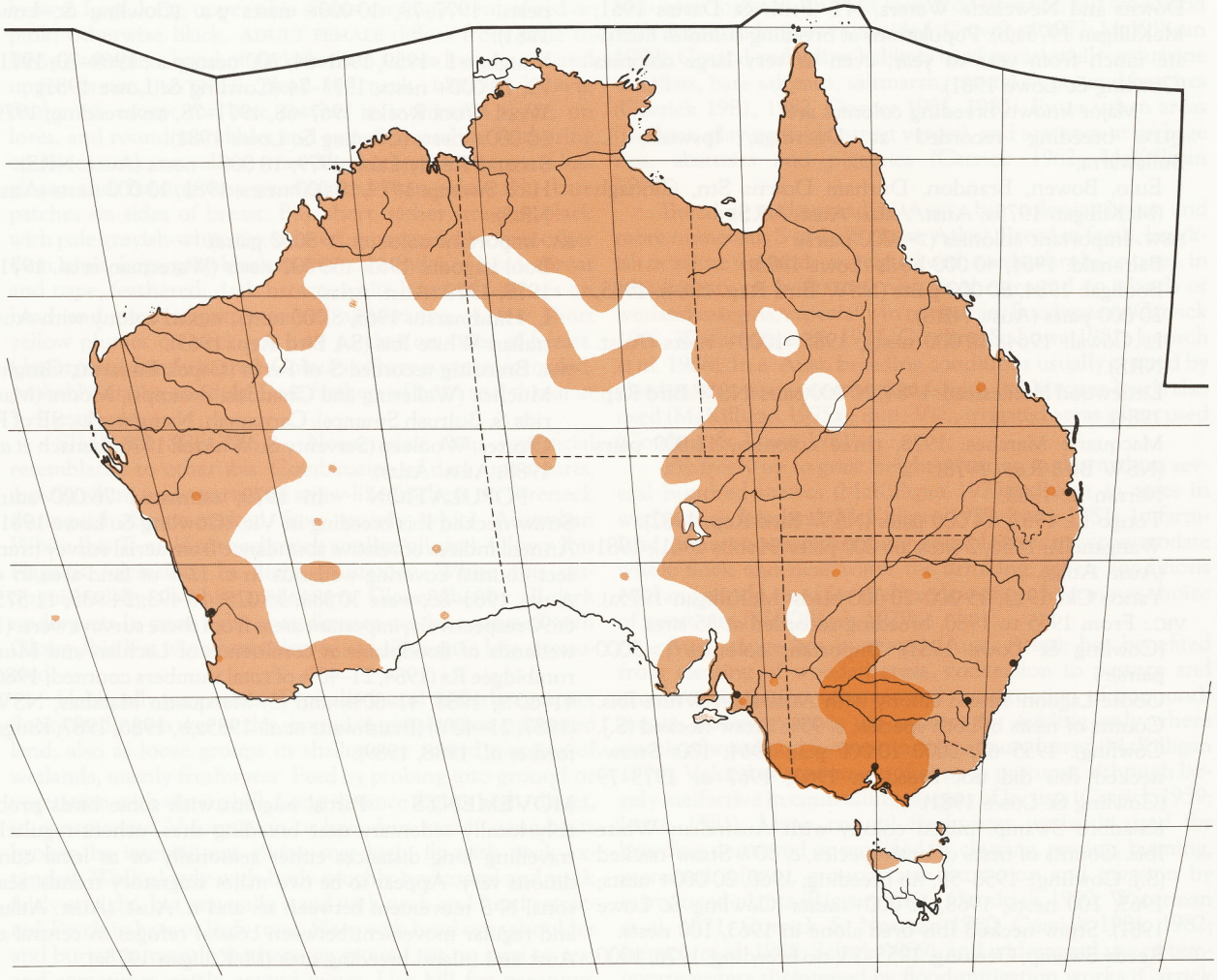
L. Hindmarsh: 1965, 8,000 nests, mixed colony with Australian White Ibis (SA Bird Rep. 1965).

WA. Breeding recorded S of Perth (Capel, Pinjarra), Gingin-Muchea (Wallering and Chandala Swamps), Moora (Marrida & Bulrush Swamps), Carnamah, Namming L., SE of Pt Cloates, Wooleen (Serventy & Whittell 1976; Jaensch *et al.* 1988; Aust. Atlas).

POPULATION In 1979, estimated 76 000 adult Straw-necked Ibis breeding in Vic. (Cowling & Lowe 1981). Annual indices of relative abundance from aerial survey (transect counts) covering wetlands in *c.* 12% of land-area in e. Aust., 1983–88, were 30 384; 55 025; 16 493; 24 935; 11 575; 6690 respectively; important areas from these surveys were: (1) wetlands of floodplains at confluence of Lachlan and Murrumbidgee Rs (1984, 21–40% of total numbers counted; 1986, 41–60%; 1988, 41–80%) and (2) Macquarie Marshes, NSW (1987, 21–40%) (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989).

MOVEMENTS Partial migrant with some birds probably locally sedentary near breeding sites, others regularly travelling long distances either seasonally or as local conditions vary. Appear to be two major migratory trends: seasonal N-S movement between se. and n. Aust. (Aust. Atlas) and regular movement between coastal refuges in central e. Aust and inland breeding sites (McKilligan 1975a).





NON-BREEDING N-S movement suggested by changes in local abundance. **N. Aust.**: present Darwin, Mar.–Oct. (Crawford 1972); Alligator Rs, dry season (Morton *et al.* 1989); Julia Ck, Feb.–Aug. (McKilligan 1975a); Atherton Tableland, Apr.–Dec. (Bravery 1970; McKilligan 1975a); Innisfail, May–Aug. (Gill 1970); Magnetic I., winter months (Wieneke 1988); Rockhampton, Mar.–Sept. (Longmore 1978); w. coast C. York Pen., Mar.–Aug. (Garnett & Bredl 1985); flocks of 50–100 seen crossing Torres Str. to New Guinea from Apr. on, returning Nov.–Dec. (Draffan *et al.* 1983; S.T. Garnett). Considered regular spring and autumn passage migrant at Inverell, n. NSW (Baldwin 1975). **S. Aust.**: reporting rate in Vic. highest Nov.–Dec. (Vic. Atlas) and regular movement S noted at Middle Swan, sw. Aust. in spring (Heron 1970). Little breeding n. Aust. whereas large colonies breed regularly Sept.–Feb. in coastal s. and se. Aust. (McKilligan 1975a). However, as some birds remain in s. Aust. throughout winter and only banding studies have been of juveniles, this migratory pattern may not be representative of adult movements. Timing of migration between coastal refuges on central e. coast and breeding sites in inland NSW generally less regular and depend on rainfall. Variation in numbers in Richmond Valley correlated with rainfall in sw. NSW (Gosper *et al.* 1983) and numbers present during Oct. counts in se. Qld negatively correlated with rainfall in sw. Qld (Woodall 1985). After breeding, probably locally nomadic as wet conditions continue inland, returning to coast when inland swamps dry up (McKilligan 1975a) with small numbers remaining round permanent water (White 1987). Stimulus for departure from near Toowoomba heavy local rain ($\geq$12.5 mm) followed by fine weather and favourable winds; flocks then observed flying directly SW towards breeding sites (McKilligan 1975a). Movements of juvenile birds may account for apparent N–S movement. Dispersal of juveniles banded se. and sw. Aust. largely coastwards and N (Carrick 1962; Waterman *et al.* 1971), in inland areas probably following rivers NE (McKilligan 1975a). At Toowoomba, numbers of juveniles present (McKilligan 1975a) consistent with influx of birds from S in autumn and spring overlain by arrivals from inland breeding sites. However banded juveniles from inland sites also recovered from n. sites, one 6 years after banding (Carrick 1962), so populations not discrete and subject to wide individual variation. Population breeding in sw. Aust. probably mix with e. birds in n. Aust.; five birds banded as chicks in SW recovered in N and two in E (Lowe 1984) with dispersal after fledging generally N (Fuller & Lindgren 1958). Distance travelled N by birds banded in SA tended to be correlated positively with age, which suggests that at least part of population does not return S (Waterman *et al.* 1971) and there is no evidence of philopatry (Lowe 1984).

BREEDING When breeding, travel up to 30 km to feed (Waterman *et al.* 1971).

BANDING Returns (all ABBBS) from se. SA summarized Fig. 1; from sw. NSW, Fig. 2; Macquarie Marshes, nw. NSW, Fig. 3; sw. WA, Fig. 4.

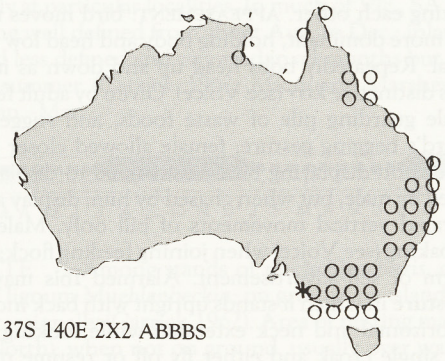


Fig. 1. 37S 140E 2X2 ABBBS

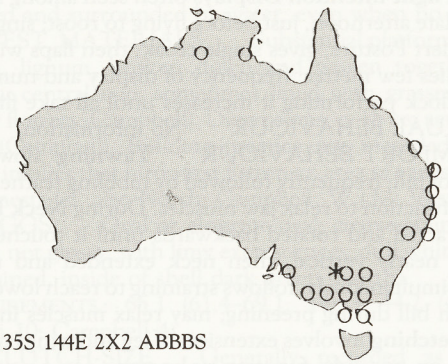


Fig. 2. 35S 144E 2X2 ABBBS

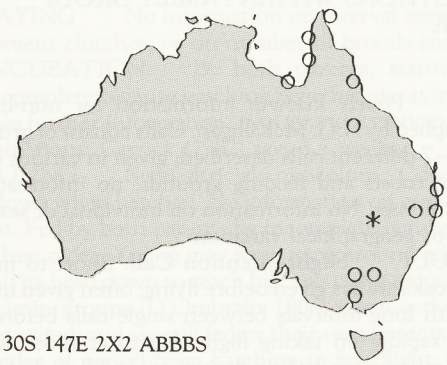


Fig. 3. 30S 147E 2X2 ABBBS

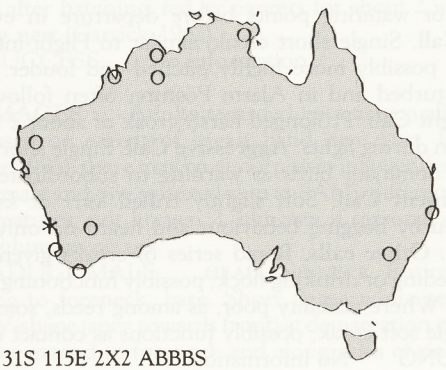


Fig. 4. 31S 115E 2X2 ABBBS

FOOD Wide range of small animals depending on habitat but including freshwater crayfish, frogs, fish, beetles, crickets, grasshoppers, caterpillars, spiders and freshwater snails. BEHAVIOUR. Long curved bill used for probing spider holes and crevices in soil, tussocks of grass and sedge or into shallow water (McKilligan 1979); occasionally probe for food while perching in trees (Haffenden 1981). Visible prey pursued and seized and will steal food from conspecifics. Toads flipped onto their backs and their soft, non-toxic underparts eaten (McCann 1986). Feed about 75% of day, mostly morning and afternoon, with reduced activity 12:00–14:00; drinking takes 1.2–1.8% of time, usually in evening before roosting (McKilligan 1979). Food probably detected more by sight than touch (Carrick 1959). Usually feed in flocks, those on land being more co-ordinated than those in water, which tend to become fragmented. Will attend grass fires in search of flushed insects (Thomson 1935).

ADULT In samples collected **NSW, s. Qld, n. Vic.** in all months (162 stomachs, 17 756 items; Carrick 1959) major dietary components by weight, probably frogs, freshwater crayfish, orthopterans, beetles and lepidopteran larvae. Complete analysis: earthworms 0.5% no., 3.1% freq., max. per bird 45, leeches <0.1, 1.2, 2; molluscs, bivalves <0.1, 5.0, 1, gastropods 2.6, 17.3, 92; crustaceans, isopods 0.2, 4.9, 17, freshwater crayfish *Cherax albidus* 1.5, 28.3, 39, crabs *Holthuisiana transversa* <0.1, 1.9, 1; centipedes 0.3, 8.6, 8; millipedes <0.1, 2.5, 2; scorpions 0.1, 3.1, 12, spiders ads. 2.6, 46.9, 151, egg-sacs 0.1, 10.5, 3; insects, odonatans Anisoptera ads. <0.1, 2.5, 2, nymphs 0.5, 9.9, 8; cockroaches 1.0, 14.2, 79; earwigs 0.1, 4.9, 10; orthopterans *Phaulacridium marginale* 0.3, 4.3, 26, unident. Gryllacrididae 0.2, 0.6, 1, Tettigoniidae <0.1, 1.9, 2, Gryllidae 31.9, 40.7, 443, Gryllotalpidae 0.1, 2.5, 12, Acrididae *Aiolopus tamulus* 0.2, 8.6, 9, *Austroicetes cruciata* 0.2, 2.5, 27, *A. vulgaris* 0.1, 1.9, 8, *Brachyexarna lobipennis* 0.6, 3.7, 42, *Chortoicetes terminifera* ads. 0.5, 9.3, 39, nymphs 4.2, 0.6, 737, *Coryphistes* <0.1, 1.3, 1, *Cratilopus* <0.1, 0.6, 3, *Ecphantus quadrilobus* <0.1, 0.6, 1, *Gastrimargus musicus* <0.1, 1.9, 1, *Oedaleus australis* 0.1, 4.9, 10, *Parelytrana rana* <0.1, 0.6, 7, *P.* sp. 0.3, 5.6, 14, *Patanga guttulosa* 3.9, 27.2, 73, *Peakesia hospita* 0.7, 8.0, 58, *Praxibulus* 1.2, 6.2, 92, *Pycnostictus seriatus* <0.1, 0.6, 1, *Schizobothrus flavovittatus* <0.1, 2.5, 2, *Zabrala* 0.2, 3.1, 17, unident. Acrididae 0.4, 6.8, 33, *Monistria pustilifera* <0.1, 0.6, 1; bugs Cicadidae 0.2, 0.6, 35, Notonectidae/Corixidae 1.9, 7.4, 316, Pentatomidae 0.6, 7.4, 47; lacewings Myrmeleontidae <0.1, 1.9, 3; beetles Carabidae 4.0, 53.7, 200, Dytiscidae/Gyrinidae/Hydrophilidae ads. 0.7, 23.5, 17, larv. 2.4, 15.4, 181 (1.3 cm), Lucanidae <0.1, 0.6, 1, Scarabaeidae 1.9, 14.8, 97, Elateridae/Tenebrionidae ads. 0.5, 20.4, 11, larv. 5.4, 12.4, 432, Coccinellidae <0.1, 3.1, 1, Curculionidae 2.0, 32.1, 87; lepidopterans Noctuidae ads. 2.1, 2.5, 362, pupae 0.2, 5.0, 24, larv. 17.6, 34.6, 442; flies Tipulidae larv. 0.6, 1.9, 107, Syrphidae larv. 1.6, 0.6, 276, other ad. flies <0.1, 3.1, 2, larv. <0.1, 1.2, 4; hymenopterans Pergidae pupae <0.1, 1.2, 2, Ichneumonidae <0.1, 1.2, 1, Apidae <0.1, 1.9, 3, Formicidae 0.2, 6.2, 12 (0.4 cm); fish 0.2, 5.0, 12; frogs 2.9, 37.0, 38; lizards 0.1, 3.7, 6, snakes <0.1, 2.5, 4; rats/mice <0.1, 1.2, 2. Dietary composition varied greatly between individuals, even when feeding in the same flock.

In **sw. NSW** (four stomachs; McKeown 1934) insects orthopterans *Gryllotalpa*, *Chortoicetes terminifera* (100% freq.), beetles *Catadromus*, *Carenum*, *Hydrophilus*, Scarabaeidae, *Phalidura*, lepidopteran larv., spiders, centipedes all 25%. At **L. Cowal, NSW** (15; Vestjens 1977) earthworms 7% freq.,

freshwater crayfish 7, shrimps 7, centipedes 7, spiders 33, spider egg-sacs 13, insects dragonflies 7, damselflies 7, cockroaches 13, earwigs 13, crickets 80, mole-crickets 13, short-horned grasshoppers 40, shield-bugs 7, ground beetles 40, waterbeetles 67, chafers 40, click beetles 20, tenebrio beetles 27, leaf beetles 13, weevils 40, beetle larv. 40, fly larv. 7, caterpillars 7, ants 27, freshwater mussels 7, freshwater snails 13, frogs 7.

Other records: molluscs (van Tets *et al.* 1977) incl. snails *Helix* (Rose 1973), water snail; crustaceans, crabs (Mathews 1909); centipedes (Gray 1938) incl. *Ethmostigmus rubripes* (8–12 cm; Rose 1973); spiders (North; Gray 1938; van Tets *et al.* 1977; McKilligan 1979) incl. *Lycosa* (Rose 1973); insects, odonatans dragonflies (Jarvis 1943), orthopterans *Teleogryllus* (Rose 1973), *Chortoicetes terminifera* (Cowling 1974), crickets (North; Ellis 1958), grasshoppers (White 1919), Gryllacrididae (van Tets *et al.* 1977), beetles (North) incl. Carabidae (Rose 1973), Staphylinidae (Gray 1938), Scarabaeidae (Rose 1973), Curculionidae (Gray 1938; Rose 1973), lepidopteran larv. (Pennycook 1920; Gray 1938; Rose 1973) incl. Sphingidae (Berney 1907); toads *Bufo marinus* (McCann 1986), frogs; lizards (North), snake *Pseudonaja nuchalis* (Schulz 1986); mice, rats; abattoir refuse and other wastes of human origin (McKilligan 1979).

SOCIAL ORGANIZATION Gregarious throughout year. Occasionally solitary; if so, usually fully grown juveniles, which may be foraging in an atypical habitat (e.g. stream bed in rainforest). Feeding flocks of two to hundreds of ibises, roosting flocks 10–350.

BONDS Assumed to be monogamous. Both parents incubate and tend young until 2 weeks after fledging (Carrick 1962).

BREEDING DISPERSION Colonial; often in vast congregations.

ROOSTING Communal, nocturnal. At Toowoomba, roost in tall (>21 m) eucalypt trees, choosing woodland large enough to accommodate whole flock as well as being closest to water where they drink at dusk. When wind strong and temperature low, use more sheltered woodland farther from drinking site. In late afternoon on such days birds congregate on ground by drinking site, moving to roost trees *en masse* later than usual, i.e. when almost dark. If still windy following morning, leave roost earlier than usual and congregate on low ground for 30–60 min before flying to feeding grounds. Thus, roosting behaviour apparently adapted to avoid excessive exposure to cold winds. Often rest in middle of day in trees near drinking site or at feeding grounds (McKilligan 1979; J. Bell).

SOCIAL BEHAVIOUR Based mainly on McKilligan (1975a,b, 1979) and information supplied by N.G. McKilligan on non-breeding Ibis. No information on sexual behaviour. Non-breeding Ibis maintain inter-individual distance through avoidance, threat displays of varying intensity, fighting, appeasement and fleeing; extent of spacing not documented.

AGONISTIC BEHAVIOUR THREAT DISPLAYS among birds in feeding flocks: aggressive or dominant bird **Stares** at opponent perhaps uttering single croak, which may be enough to deter rival. In more serious contest, aggressor walks towards opponent with bill tilted to horizontal, head lowered to level of back and wings held out from sides of body. This may develop into CHASE when aggressor lunges at, runs with wings outstretched, or flies after the other with bill held nearly horizontal and slightly open. FIGHTS involve **Bill-fencing** or **Wrestling** in which combatants flap wings, jump a metre or so into air and clash with bills and feet. Evenly matched contest sometimes ended when one or both birds stop to peck at ground and move apart; or both may turn away, following tight circle as they peck, but resuming fight when facing each other. APPEASEMENT: bird moves towards another, more dominant, holding body and head low and bill horizontal. Repeatedly bobs head up and down as it moves and emits distinctive *krrr* (see Voice). Given by adult female to adult male guarding pile of waste foods, and suggestive of young bird's begging gesture; female allowed closer to food than other non-displaying birds; continued to display when threatened by male, but when chased by him, display abbreviated to rapid vertical movements of bill only. Males often heard croaking (see Voice) when joining feeding flock; may be some form of self-advertisement. Alarmed Ibis may adopt **Alert Posture** in which it stands upright with back inclined *c.* 45° to horizontal and neck extended while looking round; may give single croak and either fly off or resume previous activity. **Flight-intention Displays** often seen among feeding Ibises in late afternoon, just before flying to roost; single bird adopts Alert Posture, gives single croak, then flaps wings, or runs or flies few metres; frequency of display and number of birds in flock performing it increases until all take flight.

SEXUAL BEHAVIOUR No information.

COMFORT BEHAVIOUR **Yawning**: slow opening wide of bill; frequently followed by nibbling feathers with bill; may function to relax jaw muscles. During **Neck Reflex**, head retracted and rotated backwards until it touches back with bill nearly vertical, then neck extended and rotated forward simultaneously; follows straining to reach lower foreneck with bill during preening; may relax muscles in upper neck. **Stretching** involves extension of leg and wing (and perhaps tail) on one side; function unknown.

RELATIONS WITHIN FAMILY GROUP No information.

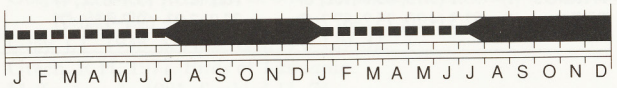
VOICE Poorly known; information for non-breeding birds supplied by N.G. McKilligan. Calls consist of grunts and croaks; 5–7 different calls described; given in various circumstances at roosts and feeding grounds; no information for birds at colonies. No information on individual or sexual differences or geographical variation.

ADULT **Flight-intention Call**. Short to medium-length croaks always given before flying; often given intermittently with long intervals between single calls before flight; repeated rapidly on taking flight. Heard at roost at dawn, repeated more often before departure, and heard at feeding grounds or watering points before departure in evening. **Alarm Call**. Single short croak, similar to Flight-intention Call, but possibly more highly pitched and louder. Given when disturbed and in Alarm Posture; often followed by flight. **Fight Call**. Prolonged harsh croak of about 2 s duration; given during fights. **Aggressive Call**. Single short grunt given by dominant birds as warning to subordinate birds. **Appeasement Call**. Soft slightly trilled *kurr* or *krrr*; accompanied by Begging behaviour and heard on only a few occasions. **Other calls**. Rapid series of croaks given when joining feeding or drinking flock; possibly functioning as Advertising. Where visibility poor, as among reeds, sometimes utter single soft croak; possibly functions as contact call.

YOUNG No information.

BREEDING Based on studies by Carrick (1962) and McKilligan (1975a,b). Information supplied by N.G. McKilligan. Breed in simple pairs, colonially, usually with other ibises, spoonbills, herons, egrets.

SEASON Varies in different districts, much influenced by level of water, flooding, drought; may not breed annually at particular localities. In much of Vic., SA, sw. WA, breeding well defined from about Aug. to Dec.; inland NSW, sw. Qld less defined and reported in all months but mostly in spring-summer (Carrick 1962, Macquarie Marshes); rest of WA, Jan.–Mar.



SITE Among stands of reeds *Eleocharis*, cumbungi *Typha*, lignum *Muehlenbeckia*; on ground on islands; in trees very occasionally (Carrick 1962). Area of nesting may cover *c.* 3 ha (North); when not on ground, usually over water <1 m deep (Carrick 1962). Colonies usually out of sight in large reedbed and surrounded by water, even when no flooding.

NEST, MATERIALS Substantial platform of reeds, rushes, lignum, broken down and woven together, with shallow central cup, sometimes lined with grasses (North), yellow flowers (Campbell). Dimensions: *c.* 15 cm across, 5 cm thick (Campbell). Building practice not recorded; Carrick (1962) implies that birds first flatten an area of reeds and then build nests (cf. also North; Campbell; W.J.M. Vestjens).

EGGS Oval or elongate oval; coarse-grained, finely pitted, not glossy, with limy excrescences; dull white, becoming stained, inside of shell dark green (North).
MEASUREMENTS.: 65.1 (61.4–69.1; 14) x 44.2 (42.4–47.0) (North 10; Campbell 4).

CLUTCH-SIZE Generally recorded as 2–5: no quantified data from definitely completed clutches.

LAYING No information on interval between eggs, replacement clutches, or on number of broods annually.

INCUBATION By both parents, starting before clutch complete because hatching asynchronic, at intervals of 48 h. No further information. INCUBATION PERIOD. No good determinations. Carrick (1962) says 3.5 weeks.

YOUNG Semi-altricial, nidicolous. Covered with black down when hatched. No information on growth, development. Fed by both parents by incomplete regurgitation, at least when older. Young may wrap wing around adult's neck and pull its head down to reach bill. NESTLING PERIOD. Young assemble in groups (D'Ombrain 1906) when active enough (age not stated) and are still fed by their own parents. No exact knowledge of period from hatching to first flight; fledging 4 weeks after hatching; fed by parents for about 2 weeks after leaving nest (Carrick 1962).

SUCCESS No information.

PLUMAGES Adults regarded here as sexually dimorphic based on extent of breast band (see Aust. RD *contra* Pringle 1985); there may be dimorphism in juveniles (based on one female and one unsexed skin at SAM); differences, if any, in immatures, not known. Unknown if seasonal changes of adult plumage occurs.

ADULT MALE HEAD AND NECK. Entire head, extending to foreneck, bare. Short dense white semiplumes, form V-shape (apex towards front) at demarcation of bare skin at nape; extend to foreneck and along sides of neck to mid-neck; gradual transition at mid-hindneck with short dark brown (121) to glossy dark-green (262) tipped feathers. From lower foreneck to base of neck, numerous long and exposed straw-like rachis; feathers basally white (see Fig. 5 Australian White Ibis). Rest of neck, dark brown (121) with glossy dark-green (262) tips. UPPERPARTS. Feathers, except on rump, basally dark brown (121). Feathers of upper mantle, glossy dark-green (162A), fringes purple (172); in some lights, fringes glossy golden yellow-olive (52). Rest of mantle, feathers horizontally barred, alternating black-brown (119) and purple (172). Feathers of outer mantle, barred on outer webs; centrally on both webs. Lower mantle feathers elongate, *c.* 120 mm long, with rounded tips to webs; similarly barred, with narrow golden yellow-olive (52) glossy fringes. Lower innermost scapulars, similar. Longer outer scapulars, alternately barred black-brown (119) and combination of mauve (172C) and gold; rachis, grey-black (82) at tip, light brown (223C) at base. Back, black-brown (119) with fringes of glossy golden yellow-olive (52), appearing blue (168B) in some lights. Upper rump similar to back, except distal halves of lowermost rump-feathers, barred blue (168B) to purple (172B) in some lights. Basal halves of feathers, black-brown (119). TAIL, white. UPPERWING. Tertials, black-brown (119); barred, alternating silver to gold, with slight purple (172B) shade; intervening bars of dark black-brown (119) on outer edges of webs; rachis, dark brown (219). Secondaries similar; barred mid-way along feather, on outer webs; base of inner webs pale dark-brown (121). Primaries and alula, black-brown (119); slight glossy golden yellow-olive (52) tip on inner web of alula. Greater primary coverts, black-brown (119) with slight glossy dark-green (162A) tips and edges of outer webs. Greater coverts, similar to secondaries. Median coverts, barred purple (172B) on both webs; slight fringe of glossy golden yellow-olive (52); barring progressively reduced and glossy golden yellow-olive (52) fringes more prominent towards marginal coverts. Alula, black-brown (119). UNDERPARTS. Outer upper breast-feathers, glossy dark-green (162A); basally, dark brown (221); form incomplete band across breast; feathers centrally all white; base of straw-like rachis, dark brown (221). Entire underparts, white; aftershaft on upper breast, wide and fluffy. Patch alongside axillaries, on outer breast, bare. UNDERWING. Greater primary coverts, pale dark-brown (121). Median, lesser primary coverts and median coverts, black-brown (119). Marginal coverts similar with slight glossy dark-green (162A) tinge. Lesser coverts, white; form stripe from carpal joint to body. Greater coverts, very pale dark-brown (121). Axillaries, long and white.

ADULT FEMALE Similar to adult male, differences described here only. HEAD AND NECK. Across lower neck and breast, complete wide band of dark feathers; at lower neck, bases of straw-like rachis, dark. Feathers, dark brown (221) basally; tips glossy purple (172), appearing glossy dark-green (162A) in some lights. White semiplumes of neck, thinner than in male.

NESTLING HEAD AND NECK. Down of head and neck, black-brown (119); dense and hairy on crown. Chin, bare; throat and foreneck, sparsely covered in short dark-brown (119A) down. UPPERPARTS., dark brown (119A). UNDERPARTS. Down, white, except for flanks, which are light grey-brown (119C); down on flanks long and hairy. WING., similar to upperparts.

JUVENILE HEAD AND NECK., black-brown (119), apart from bare patches in interramal space, loral skin, round mandibles and orbital area. Some white feathering on lower

neck, probably more so in males. No straw-like rachis present. Entire upperparts, including wings, dark brown (221); little barring present. On mantle, some purple (172B) fringes present. Breast band in females, similar to upperparts; rest of underparts, white. No bare patch on outer breast. Tail and underwing similar to adult, except latter has no glossy fringes on marginal coverts.

IMMATURE Adult plumage attained gradually, by balding and colouring of plumage. HEAD AND NECK. Crown, dark brown (121). Sides of head, chin, throat and nape, dark brown (119A); feathers of head and neck basally white, producing streaked appearance; some feathers entirely white. Straw-like rachis short and fewer on neck. Hindneck, dark brown (121). UPPERPARTS. Mantle, dark brown (121) with slight purple (172B) and glossy golden yellow-olive (52) fringes. Scapulars similar. Back and rump similar, gloss subterminal with narrow blackish-brown (219) fringing. UPPERWING. Primaries, black-brown (119). Secondaries and tertials similar but very faintly barred purple (172B) to gold on outer webs. Greater coverts, dark brown (121); edge of outer web, faintly barred purple (172B). Rest of coverts, dark brown (121); in worn plumage, tips light dark-brown (121A). In some lights, outer webs of coverts, faintly barred purple (172B). Greater primary coverts similar to primaries. Alula, also similar, but with faint dark-green (162A) gloss on outer web. UNDERPARTS. Upper breast, dark brown (121); a few tips on upper breast feathers, light grey-brown (119C). Rest of underparts, white. No bare patch on outer breast. UNDERWING. and axillaries, similar to adult.

BARE PARTS Based on label data on skins (SAM; colours of bare parts recorded 3.5 h after death).

ADULT MALE Bill, blackish with rugose plates on sides, pale olive and blackish. Iris, dark brown. Bare skin of head and neck, grey-black. Upper tibia, light pink with black lines; rest of leg, blackish red; toes blackish; soles, ochraceous black. Hind-palate, dark grey; forepalate, olive grey; bill, mid-grey. Outer breast patches, greenish yellow.

ADULT FEMALE Bill, black; rugose plates pale olive and blackish. Iris, dark brown. Bare skin of head and neck, greyish black. Lower eyelid, whitish to pale grey-white. Upper tibia, bright red-pink; lower frontal tibia and frontal tarsus, dull greyish red; hind lower tibia, hind tarsus and toes, blackish; soles paler. Palate, dark grey; hindbill, pale olive; forebill, pale grey. Bare patch on outer breast, greenish-buff, dull orange-yellow to bright mustard-yellow.

NESTLING Bill, basally blackish; distal half, very pale orange-pink; above nostrils, fuscous pink. Iris, dark brown. Legs and feet, dull dark purplish grey. Mouth, dull buffy red.

JUVENILE Bill, fuscous black; tip, pale grey-white. Iris, umber; pale-grey outer ring. Legs, blackish grey; above knee and inner leg, mid-grey.

IMMATURE Few data, probably similar to adult.

MOULTS Largely undescribed.

ADULT POST-BREEDING Complete; primaries outwards. Duration and timing unknown.

ADULT PRE-BREEDING May involve acquisition of more extensive straw-like rachis-bearing feathers.

POST-JUVENILE Undescribed; presumably partial.

SUBSEQUENT MOULTS Little known; involves balding of head.

MEASUREMENTS Few data. (1) Skins (SAM, MV). (2) Healesville Fauna Park, Vic., live; methods unknown (ABBBS).

		MALES	FEMALES	
WING	(1)	387.7 (13.6; 364–415; 8)	363.2 (7.68; 351–375; 7)	*
8TH P	(1)	237.8 (7.01; 227–246; 7)	224.1 (8.20; 215–237; 7)	*
TAIL	(1)	141.2 (9.16; 130–152; 7)	135.5 (4.74; 126–142; 7)	
BILL	(1)	167.2 (7.99; 158.2–179.8; 8)	137.7 (3.16; 133.4–142.2; 6)	*
	(2)	172.3 (12.11; 156–185; 3)	131.5 (6.98; 120–138; 4)	
TARSUS	(1)	93.1 (5.75; 83.6–102; 8)	78.7 (2.57; 75.4–83.2; 7)	*
TOE	(1)	82.3 (4.20; 75.2–87.2; 7)	77.9 (7.03; 69.7–93.6; 7)	

WEIGHTS Few data. Healesville Fauna Park, Vic., live; methods unknown (ABBBS): males 1465.0 (74.94; 1400–1570; 3), females 1237.5 (73.61; 1150–1320; 4). No data on seasonal changes.

STRUCTURE Wing, long and broad. Eleven primaries: p8 usually longest 0–2, p10 13–15 mm shorter, p9 0–5, p7 1–9, p6 24–34, p5 55–68, p4 80–86, p3 95–104, p2 112–119, p1 120–119, p11 minute. Sixteen secondaries, four of tertial form. Tail, square; 12 rectrices, t1 or t3 longest, t6 *c.* 15 mm shorter; prone to wear. Bill, long, rather heavy and decurved, high at base and laterally compressed. Narrow concave ridge on culmen; deepest at base, where slit-like nostrils situated. Side of upper mandible at base, rough with vertical rugose plates; smoother in juveniles. Head and upper neck, bare in adult; feathered (except for skin in interramal space, round mandibles, loral and orbital area) in juvenile and immature. Bare patch of skin on outer breast, near axillaries. Lower half of tibia, bare. Legs and toes, slender; claws long and slightly decurved. Outer toe *c.* 77% of middle, inner *c.* 69%, hind *c.* 39%.

GEOGRAPHICAL VARIATION Monotypic. Merged with *Threskiornis* on basis of lack of ornamental plumes (Holyoak 1970). Possible hybridization with *T. aethiopicus* but no details given (Bekle 1982).

RMO

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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