

ment of the Cairns Bird Park for the loan of the Grass Owls. Peter Wilson and Ken Bullen provided an invaluable liaison which made the study of the Grass Owls possible.

REFERENCES

- BUNN, D.S. 1977. The voice of the Barn Owl. *British Birds* 70: 171.
- , & A.B. WARBUTON. 1977. Observations on breeding Barn Owls. *British Birds* 70: 246-256.
- J.D. PETTIGREW, L. LITTLE AND T. STEGINGA, *Neuroscience Laboratory, Department of Physiology and Pharmacology, University of Queensland, St. Lucia, Queensland, 4067*
- , ———, & R.D.S WILSON. 1982. The Barn Owl. Carlton, U.K.: T. & A.D. Poyser.
- FLEAY, D. 1949. The Tasmanian Masked Owl. *Emu* 48: 169-176.
- . 1968. *Nightwatchmen of Bush and Plain*. Sydney: Jacaranda Press.
- McLACHLAN, R. & R. LIVERSIDGE. 1978. *Roberts Birds of South Africa*. Cape Town: John Voelcker Bird Book Fund.
- SCHODDE R. & I. MASON. 1981. *Nocturnal Birds of Australia*. Melbourne: Lansdowne Press.
- SMITH, D.G., C.R. WILSON, & H.H. FROST. 1974. History and ecology of a colony of Barn Owls in Utah. 76: 131-136.

Received 29 May 1985; accepted 13 August 1985

BEHAVIOUR OF THE LITTLE PIED CORMORANT *PHALACROCORAX MELANOLEUCOS*

Some authors (cited in van Tets 1965, 1976) propose that five species of *Phalacrocorax* (i.e., the microcormorants) should be placed in a separate genus *Haliastur* or *Microcarbo*. The species concerned are the Pygmy Cormorant (*P. pygmaeus*), from North Africa and central Europe east to Afghanistan; the Reed Cormorant (*P. africanus*), from Africa and Madagascar; the Crowned Cormorant, (*P. coronatus*), from the west coast of Southern Africa; the Little Cormorant (*P. niger*) from India south-east to Borneo; and the Little Pied Cormorant (*P. melanoleucos*), from New Guinea, Australia and New Zealand (Landsborough-Thomson 1964; G.F. van Tets pers. comm.). All four species live in marine and freshwater environments and are distinguished by their generally small size and relatively long tails. The validity of *Microcarbo* as a taxon is debatable (van Tets 1965, 1976) because of gaps in our knowledge that could be at least partly filled by study of behavioural homologies among the microcormorants. However, so far as we are aware the behaviour of no microcormorant has been detailed except for brief, unclear descriptions of *P. africanus* by Olver (1984). Therefore it is not possible at present to make comparisons, either within that small group, or between the microcormorants and other phalacrocoracids.

For *P. melanoleucos*, work in coastal Manawatu, New Zealand between January 1981 and May 1983 was partly designed to provide information on all maintenance and social behaviour during breeding at the

colony. Observations were made in two localities involving colonies of about 11 and 13 pairs at an ox-bow lake 23 km from the coast, and 22 pairs at a dune lake 1 km from the coast. Nesting occurred on a disused hunters' blind and in trees overhanging the water. From this work emerged several discrete areas of behaviour, which, according to the literature, contained differences to other phalacrocoracids.

In this note we draw attention to some postures and patterns of behaviour in *P. melanoleucos* that appear distinctive to us, and which could help in better understanding relationships between microcormorants and other phalacrocoracids. This note is based on a total of 700 h of observations made three days each week from a hide, with 7 × 50 and 13 × 30 binoculars. Photographs were taken to augment field notes and diagrams.

Normal

In the Normal posture the neck assumes a characteristic 'S' bend, and the bird appears to be relaxed even when it moves its head to scan the surroundings. The angle that the body makes with the substrate ranges from near vertical in calm conditions, to near horizontal in very strong winds, when the tail is also used as a counter-balance. The 'normal' posture (Fig. 1.1A) described here is not unique among cormorants, but is a socially 'neutral' posture with which other displays in this species may be contrasted.

Male advertising

The male attracts potential mates with two displays, which may be performed independently of each other; the 'Squat-thrust' and 'Gape-bow'. These displays are also known as 'Wing-crouching' and 'Bowing' respectively (G.F. van Tets pers. comm.).

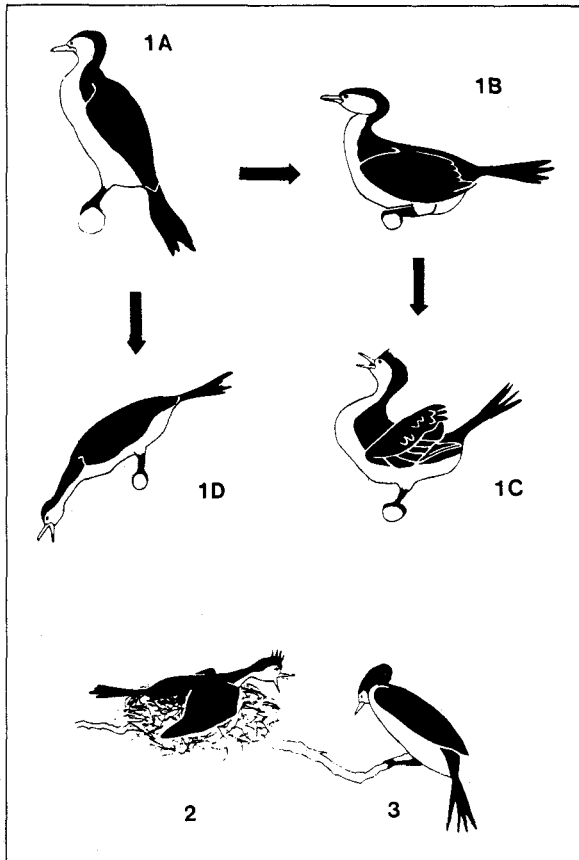


Figure 1. Behavioural postures of the Little Pied Cormorant. 1A, normal posture; 1B and 1C show squat, and thrust, respectively of squat-thrust display; 1D, gape-bow; 1.2, high intensity threat; 1.3, appeasement.

Birds about to perform the squat-thrust initially stand erect in the normal posture but with their wings held slightly away from the body but still folded. Squatting to a near sitting position (Fig. 1.1B), the bird thrusts quickly upwards, during which the chest rapidly expands, the wings extend further from the body, the forehead crest is raised and feathers are ruffled (particularly on the side of the head), the tail is slightly elevated, and a two-syllable 'uh-aah' call is given (Fig.

1.1C). The display can vary in intensity and is usually performed repeatedly. According to van Tets (1965) the squat-thrust is analogous to 'sky-pointing' (in sulids) and to 'wing-waving' (in phalacrocoracids). The main characteristic of the squat-thrust is that the body switches position from standing to squatting and back again. In other phalacrocoracids head and neck movements are emphasised. The squat-thrust is unique among the phalacrocoracids so far described in that the wings are raised once per display, instead of repeatedly (van Tets 1965).

The second display commonly seen in male-advertising is the gape-bow (Fig. 1.1D). The male stands erect, then his whole body and neck is vigorously stretched forward and downward, so that the head reaches below the feet. The beak is opened at the bottom of the downstroke and a loud but clear one-syllable call is made. The male holds his wings close to the body, while the tail is more or less in line with the body. The posture is repeated every 1½–2 sec in bouts that may last upwards of one minute. Shorter bouts may also be alternated with squat-thrusts. While the gape-bow looks similar to the 'gape' and 'throwback' displays of most other cormorants, it is unusual in being performed when the female is not close to the nest site. To our knowledge, only in *P. penicillatus* (Williams 1942) is the gape-bow equivalent performed as part of the male-advertising display. In most other cormorants this behaviour is believed to function as a recognition display performed by the individual at the nest site and, depending on the species, it may be performed by one or both of the sexes.

Vestjens *et al.* (1985) refer to the gape-bow as the recognition display of a male to the arrival of an 'actual or potential mate'. While there is a recognition display between members of a pair that closely resembles the gape-bow (except that there is no call or vertical body switching), the following observations suggest that the gape-bow is a male advertising display.

(i) If the gape-bow functions as a recognition display one would expect a positive response to be elicited as a result. However, the gape-bow is often directed at a female passing overhead in flight, and can be unsuccessful in eliciting a response in such a situation. This suggests a failed attempt at attraction of the female by the male.

(ii) Both the squat-thrust and gape-bow feature body-switching, which is seen only during the earliest stages of courtship and nowhere else in the bird's behaviour. This suggests a possible link in derivation or function.

(iii) The gape-bow has a distinctive associated call (a single, long, constant note), which is heard at no other time and in no other situation. After the completion of

pair formation, an incoming bird commonly gives a greeting call consisting of a series of short, harsh 'aarks'. As this call is totally unlike the one given during the gape-bow, it suggests a separate function.

(iv) Male advertising of *P. penicillatus* (Williams 1942) features two displays, one of which is clearly the equivalent of the squat-thrust (wing-waving). The second display (the 'stroke' — Williams 1942) is almost identical in description, duration and context to the gape-bow, except for the lack of vertical body switching. Williams does not describe a call for this display, but mentions that the bill is opened at the end of the downstroke.

Calls

The vocal repertoire of the Little Pied Cormorant is very limited. Adults in the colony are generally silent, and take off silently, unlike many other shags and cormorants (van Tets 1965; Millener 1972). The most distinctive calls relate to male advertising (mentioned above) and to alarm. An alarm call is invariably made by adults in response to the close approach of an aerial predator (e.g. the Marsh Harrier (*Circus aeruginosus*) or the Kelp Gull (*Larus dominicanus*)). The call (a loud, repeated 'coo') is initiated by the first adult to see the predator, but within one or two seconds spreads throughout the colony. The call is only given when chicks are present, and causes them to fall silent, huddling at the bottom of the nest. In Australia, the alarm calls are described as croaking sounds (Vestjens *et al.* 1985). According to Vestjens *et al.* (1985) most other pelecaniforms lack an alarm call. As the Little Pied Cormorant is generally unaggressive (see below), an alarm call could also serve as an 'early warning system' enabling other adults to escape if necessary.

Agonism

Like other phalacrocoracids (Snow 1960) aggressive displays in the Little Pied Cormorant involve pointing the bill at the opponent, while appeasement displays are characterized by the bill directed away from the aggressor (Fig. 1.3). In low intensity threat the Little Pied Cormorant points the bill towards its antagonist, while at medium intensity the head is moved backwards and forwards in the median plane. At the highest intensity of threat (Fig. 1.2), the forehead crest is fully raised, the tail slightly elevated, and the wings may be partially raised. The bill is thrust repeatedly towards the intruder and widely opened at the forward limit of each thrust. When fighting the birds spread their wings, peck at their opponent's bill and attempt to grab hold of each other's wings. From examples given in van Tets (1965) fighting is broadly similar throughout the order, but in the Little Pied Cormorant fighting appears to be rare (in 19

months of observations only one fight was seen).

Interactions between the Little Pied Cormorant and the Little Black Cormorant (*P. sulcirostris*) and Great Cormorant (*P. carbo*) respectively, suggest that the Little Pied Cormorant is the least aggressive. Lack of aggression also appears manifest in the lack of any overt anti-predator behaviour in this species. Siegal-Causy & Hunt (1981) describe the effects of predation on cliff-face nesting Pelagic Cormorants (*P. pelagicus*), and the cliff-top nesting Double-crested Cormorant (*P. auritus*). The latter species employs vigorous anti-predator behaviour while the former does not, relying on the inaccessibility of its nest sites. Similarly, the tree-nesting habit of the Little Pied Cormorant may confer on eggs and young, relative safety from predators. Ground predators may also be deterred from entering colonies in trees surrounded by, or hanging over, water.

Forehead crest

In the Little Pied Cormorant, the attitude of the forehead crest depends on whether the bird is sitting on, or standing beside, the nest; in the former instance the crest is erect, whereas in the latter it is not. Van Tets (1965) describes exactly the opposite situation in both *P. carbo* and *P. olivaceus* (Olivaceous Cormorant), where the crest is lowered in sitting birds and erect only in standing birds. Van Tets (*op. cit.*) considers that the difference in the attitude of the crest avoids confusion between sexual partners (and presumably conspecifics) as to which one is sitting or standing. Since *P. melanoleucos* also raises its crest in high-intensity threat (which *P. carbo* and *P. olivaceus* do not) we suggest, for that species, an alternative interpretation. Erection of the crest in *P. melanoleucos* may be an effective way of signalling to intruding conspecifics that the sitting bird is not simply occupying a perching site, but instead is guarding a nest and therefore will defend more tenaciously.

Although a final classification of the Phalacrocoracidae must await studies on more microcormorant species, the behavioural patterns listed above seem to support a generic separation. In particular, attention is drawn to the unique vertical switch in body position in the male advertising displays; the single wing movement in the wing-waving display; the presence of an alarm call; and the general lack of aggression in the breeding colony.

ACKNOWLEDGEMENTS

We thank Messrs A. Hamilton, M. Voss and B. Sexton for access to study areas; and the Wildlife Service, Department of Internal Affairs, for a travel grant. Drs. A.M. Bimler, J.L. Craig, G.F. van Tets, and Professor B.P. Springett commented on drafts of this paper, and Dr G.F. van Tets kindly made available original source manuscript material.

REFERENCES

- LANDSBOROUGH-THOMSON, A. 1964. A New Dictionary of Birds. London: Nelson & Sons Ltd.
- MILLENER, P.R. 1972. The biology of the New Zealand pied cormorant *P. varius varius*. M.Sc. thesis, Zoology Department, Auckland University.
- OLVER, N.D. 1984. Breeding biology of the Reed Cormorant. *Ostrich* 55: 133-140.
- SIEGAL-CAUSEY, D. & G.F. HUNT. 1981. Colonial defense behaviour in Double-Crested and Pelagic Cormorants. *Auk* 98: 522-531.
- SNOW, B.K. 1960. The breeding biology of the Shag on the island of Lundy, Bristol Channel. *Ibis* 102: 554-575.
- VAN TETS, G.F. 1965. A comparative study of some social communication patterns in the Pelecaniformes. *Ornithol. Monog.* 2: 1-88.
- . 1976. Australasia and the origin of shags and cormorants, *Phalacrocoracidae*. *Proc. XVI Intern. Ornithol. Congr.*: 121-124.
- VESTJENS, W.J.M., G.F. VAN TETS & M.J. TAYLOR. 1985. Little Pied Cormorant *Phalacrocorax melanoleucos* (Vieillot, 1817). In: Source manuscript for Reader's Digest Complete Book of New Zealand Birds. Sydney: Reader's Digest.
- WILLIAMS, L. 1942. Display and sexual behaviour of the Brandt Cormorant. *Condor* 44: 85-104.
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Received 6 June 1985; accepted 27 November 1985

TASMANIAN NATIVE-HEN *GALLINULA MORTIERII*: THE FIRST LATE PLEISTOCENE RECORD FROM QUEENSLAND

In 1983, Mr Ian Sobbe collected a complete right avian tarsometatarsus (Queensland Museum [Q.M.] F13690) from a bone-rich lens at the base of the 'Toolburra Silt' (= Pleistocene fluvial deposits; quotations are necessary as it is not considered a valid stratigraphic unit, R. Molnar pers. comm.) on the south side of King Creek, Clifton, Queensland. The tarsometatarsus is similar to that of *Gallinula mortierii* and differs from that of all other known Australian members of the Rallidae because it is larger and more robust (Olson 1975). The total length of the specimen (73.7 mm) is less than that of any other fossil or modern tarsometatarsus of *G. mortierii*. However, the proximal width (13.0 mm), least width of shaft (5.6 mm) and distal width (14.1 mm) are well within those recorded for that species (Baird 1984). Mr Sobbe has also collected from the same locality an incomplete right tarsometatarsus (Q.M. F13683) and the proximal end of a synsacrum (Q.M. F13692) of *Gallinula mortierii*, and the distal end of a left tibiotarsus of *Gallinula tenebrosa* (Q.M. F13691). The incomplete tarsometatarsus is missing the trochlea for digit III, which precludes the taking of a direct measurement of its total length. However it is comparable in size to a complete tarsus 79.5 mm length: it measures 70.0 mm from the proximal end to the distal foramen.

Gill (1978) described stratigraphic sections along both Darymple and King Creeks, where he located the bone-rich lens at the base of the 'Toolburra Silt'. C14 dates on the lens, from Clifton, include $23\,600 \pm 600$ years before present (Y.B.P.) (NZ612), $28\,400 \pm 1400$ Y.B.P. (JAK1394), and $41\,500 \pm 6100$ Y.B.P. (NZ613) on

charcoal, and, $24\,000 \pm 600$ Y.B.P. (NZ641) and $30\,800 \pm 3000$ Y.B.P. (NZ640) on carbonate nodules (Gill 1978, pers. comm.).

This is the first Late Pleistocene record of *G. mortierii* from Queensland. Earlier records of the species from the Plio-Pleistocene Chinchilla Sand (Woods 1960) were considered to be of a small subspecies of *G. mortierii*, *G. m. reperta* (Olson 1975). Baird (1984), using the larger sample sizes afforded by recently identified Late Pleistocene specimens, showed that the specimens from the Chinchilla Sand were referable to *G. m. mortierii*.

The fossil-bearing sediments yielding this species are distributed throughout eastern and south-eastern South Australia and western Victoria, and range in age from approximately 26 000 Y.B.P. to approximately 12 000 Y.B.P. Although there are numerous localities along the east coast of Australia from which fossil-bearing sediments are known, *G. mortierii* is conspicuous by its absence from this area. I assume that it never colonized the Great Dividing Range or eastern coastline of the continent. The absence of *G. mortierii* from the east coast fossil-bearing sediments, together with the new record, suggests that the prehistoric geographic distribution of *G. mortierii* was restricted to the catchment of the Murray/Darling River Systems and the coastal plain as far south as Tasmania. These areas would have provided permanent water during the Late Pleistocene (Jones & Bowler 1980). The species probably went extinct on continental Australia because of the fluctuating wet and dry cycles that occurred between 20 000 and 12 000 years ago (Baird 1984). Horton (1984) also proposes that